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OBSERVATIONS ON VASUM GLOBULUS NUTTINGI, WITH COMMENTS ON OTHER CARIBBEAN VASE SHELLS

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The information in this article is based upon the observations by Mr. John B. Henderson, Jr. (Nutting, 1919), and from field notes made in connection with the Smithsonian-Bredin Caribbean Expedition, 1958, and by Mr. Bode during two years, 1957-1958, as a Fulbright Fellow at Antigua.[2]

Information on the distribution, ecology, evolution, and systematics of the genus *Vasum* in the western Atlantic is of particular interest to the writers of this article. Since at least three species, *V. muricatum, capitellum,* and *V. globulus (Globivasum) nuttingi* (Henderson), have overlapping ranges in the Lesser Antilles, special care should be made to report the exact locality and observations of each find.

Habitat notes. Vasum muricatum and *V. globulus nuttingi* were found within a few miles of each other at Barbuda, but in distinctly different habitats. *Vasum muricatum* is generally found in or close to turtle grass beds.

VASUM MURICATUM (Born)

Anegada: from Pomato Point in shoal water on Turtle Grass flat. *Barbuda:* south shore (Gavenor's Landing). 5 specimens from shallow water, 3 to 6 feet depths, on sandy bottom in region of coral heads and nearby shoreward expanse of turtle grass. Abbott (1950) noted that "It seems to prefer rather sheltered, shallow waters, but is sometimes found on relatively exposed reefs." *Antigua:* Jumby Bay, Long Island.

VASUM GLOBULUS NUTTINGI (Henderson)

Barbuda: windward side of Spanish Point. Specimens found in shallow water along coral (dead) rock ledges and on patches of

[1] University of Delaware Marine Laboratories, Contribution No. 7.

[2] For the opportunities afforded him, as an invited member of the expedition, the senior author wishes to express his gratitude to the sponsors of the expedition, Mr. and Mrs. J. Bruce Bredin and to the expedition leader, Dr. Waldo L. Schmitt.

sand among the rocks. Roughly 40% of the specimens were within a few inches of *Diadema*. Several *Vasum* were only an inch away from the periphery of the *Diadema*. Depths were 1 to 3 feet. In only one case, a specimen was collected in another habitat: turtle grass on a sand-covered ledge of coral rock, depth 6 inches. *Antigua:* from areas just inside points of land, in semi-protected waters. As at Barbuda, where an offshore coral reef broke the direct force of the surf, the localities in Antigua were areas with well-circulated seawater but not exposed to direct surf. We found no Nutting's vase well within bays. Localities included are: Carlisle Bay: in 3 feet of water. Dead Sands: rocky area on the east side, in 5 feet of water. Ding-a-Dong Nook: in 4 to 5 feet of water. Exchange Bay and Smith Island at Mill Reef: in one to 2½ feet. Freeman's Bay: inside harbor mouth. Galley Bay: in 3 to 6 feet of water. Literally hundreds of Nutting's Vase shells containing hermit crabs were observed on the Galley Bay side of the point separating Galley Bay and Little Galley Bay. Specimens can be collected at Little Galley Bay when the sea is calm. Guana Island: at the part of the island called the Headlands, at 3 to 4 foot depths. Half Moon Bay: inside rocky area on the Mill Reef side of the bay and in 2 to 6 feet of water, along western shoreline, midway between the sand beach and the open sea to the south. Johnson's Island: northwest side, in 4 to 5 foot depths. Rendezvous Bay: in 4 feet of water; this area may be heavily populated, but extremely rough surge makes it difficult to collect; it was the only locality on Antigua where specimens were found directly exposed to the open sea. Windward Bay: in tide pools formed by a small reef of dead coral, at the water's edge to one and a half feet; in 3 to 6 foot depths outside of the tide pools.

Natural history of species of Vasum: Little is known about the living animal. *Vasum muricatum* is known to be predatory upon worms and clams (Abbott, 1954); presumably, the other species are also predatory.

In its habitat, *Vasum globulus nuttingi* escapes notice from all but the experienced collector. Nutting (1919) reported from the notes of Mr. Henderson that, "Miss Sykes seemed to be the only collector with eyes properly focussed to detect these turbinellas clinging to the rocks, so well concealed are they by their coloration and by the calcareous deposit that further hides them from their enemy (but not Miss Sykes). One of the chief enemies of these rock-living mollusks is a fish of the grouper family that at high tide swims about the reefs examining every inch of their surface for little mollusks that have not hidden themselves very carefully." Miss Esther Bates, in a mimeographed newsletter,

commented upon collecting at Carlisle Bay, Antigua, on 22 April, 1958: "The tide was low and they [natives] led us to a coral reef at the water's edge. They [Nutting's vase] are difficult to see against the rocky background but I came away with a goodly number . . ."

Vasum muricatum may be nocturnal, hiding during the bright sunlight hours among a little species of coral and turtle grass; traveling across the bottom, in 2 to 3 feet of water, in the late afternoon. This may also be the case for *V. globulus nuttingi*. Most specimens appear to be, to the collector swimming about in search of them, at rest among growths on rocks or partially covered with sand. Possibly visual, audible, or pressure stimuli, caused by the swimmer, cause the snails to "freeze." Specimens removed from the water frequently come part way out of their shells and appear to be quite active.

Three of the species have been dredged from moderate depths (Abbott, 1950; Rehder and Abbott, 1951): *V. latiriforme* (18 to 20 fathoms), *capitellum* (10 fathoms), and *globulus nuttingi* (7 fathoms). The type locality of *globulus nuttingi* was designated as 7 fathoms (Abbott, 1950), whereas the published account of the living animals (Nutting, 1919) reported them on the rocks in shallow water about the reefs at the entrance to Freeman's Bay. There is no doubt that shallow water areas are characteristic habitats; it remains to be proved that moderate depths are also usual or common. If a range in depth of habitat exists, then a seasonal migration pattern, perhaps for feeding or breeding, may be involved. In this respect, the collections by Bode and Shuster were made only in shallow water, during the period from 9 March through 25 June, 1958. A false distribution may be caused by the activities of predators, such as the grouper (Nutting, 1919), or by hermit crabs.

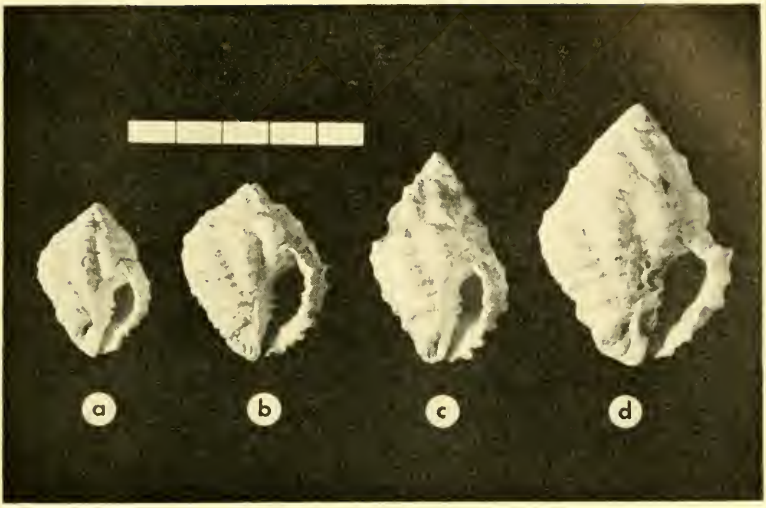
V. globulus nuttingi has been found at depths ranging from the water's edge to, as a rule, not more than 6 or 8 feet of water. In every case, except at Rendezvous Bay, the snails were found in an area protected from the direct waves of the open sea, yet they were always located where there was considerable water circulation. As a rule, they were not found in sheltered areas, as at the head of a bay. The most sheltered habitat observed by Mr. Bode was just inside the entrance to Freeman's Bay, where the snails

were found in shallow water, not exceeding a foot in depth. Their distribution in this particular area, as in several others, was restricted to a zone covered by a moss-like growth on the rocks. This growth was not collected nor identified, although it can be recognized easily again once a person has seen it. It appears like a coarse moss, ½ inch to 1½ inches long, ranging in color from a grey to a brown.

In some areas the Nutting's vase was found in the shallow water within a short distance of the beach, among rocks and dead coral, with a higher ridge of rock and dead coral between the open sea and their habitat. Often a bank of live coral would be located at the edge of this "protecting" reef and the water depths quickly dropped off to at least 25 or 30 feet. Although examples of *V. globulus nuttingi* were found in shallow water, they were within a distance generally not exceeding 50 to a 100 feet from deep water.

Specimens of Nutting's vase are frequently found partially buried in pockets of coral sand in crevasses of dead coral. When collected out in the open, on the top of rocks, they are always beneath the water's surface. No examples were ever found on living coral, although some, as at Half Moon Bay, were almost completely encrusted with what appeared to be a living coral. This coral had a very light lavender color when first taken from the water. It completely covered and hid the shape of the shell, with the exception of the aperture.

Large numbers of immature *V. globulus nuttingi* have not yet been found. In some areas only adult specimens occurred. In others, only immature examples were found and when one or two snails were found in an area they were most often immature. On the basis of these observations, since in most areas the adult specimens considerably outnumber the immature ones, we believe that either the young stages are to be found in another habitat, perhaps a breeding area, or that the adult populations are maintained by a low number of surviving immature snails. Mr. Bode has noted that the local populations can be over-fished. This observation suggests that the snails either have a wider range of distribution, as into greater depths, or more probably, there is a low level of population replenishment due to predation and other forms of mortality or to a low reproductive rate.



Figures a to d, *Vasum (Globivasum) globulus nuttingi* (Henderson), to illustrate variation in adult shells: a, the "fossilized" shell frim a kitchen midden. b, characteristic shell. c, an elongate specimen. d, the largest shell. Scale block 5 cm. in length.

An area that needs considerably more investigation comprises the small islands off the northeast coast of Antigua, and in particular, the windward side of Long Island and Guana Island. Exchange Island, Little Exchange, Hellgate, Pelican Island and Maid Island should also be more closely investigated. In this general area, dead shells have been picked up that appear to be larger and longer than those found on the south side of the island.

Among the several dozens of *V. globulus nuttingi* collected by Mr. Bode, 3 are worthy of special mention: 2 are atypical, one was found in a kitchen midden. These 3 specimens (figs a, c, d) and a more usual one (fig. b) from Barbuda (Shuster!) are depicted on page 5. An elongate specimen (fig. c) was collected alive at Windward Bay, Antigua, on 9 March, 1958. It was found at a depth of about 3 feet of water in an area consisting of broken, dead coral and coral rock, with small patches of sand. A very large shell was found in the same area. The third shell (fig. a) was found in a kitchen midden, approximately two feet below the surface, in conjunction with potshard and broken conch and murex shells. The midden site was at the western end of a "shell beach" on the north side of Antigua, between the airport and

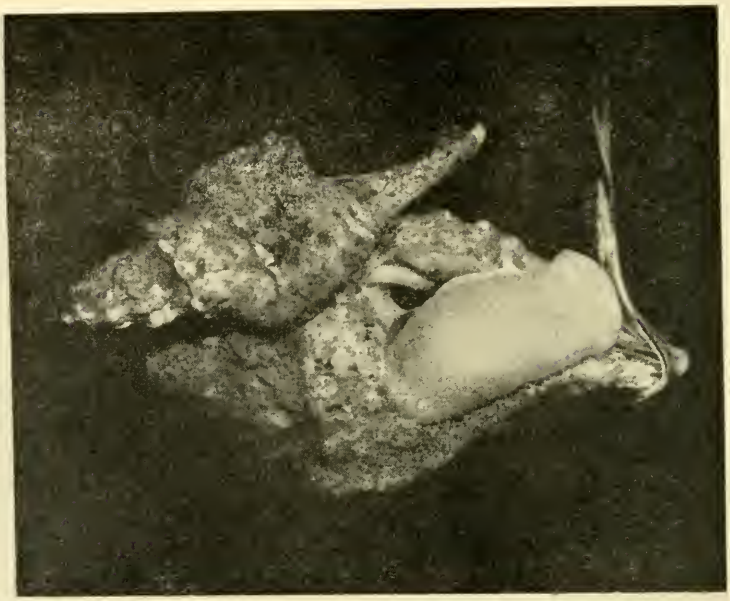


FIG. 1

FIG. 2

Eupleura caudata (Say). Fig. 1, male and female in copula. Fig. 2, two males attempting copulation with one female.

Long Island. This shell was in a bank approximately 7 feet above mean tide and 10 feet back from the water's edge. Two of these specimens were pictured at slightly larger than actual size by Shuster (1959) : the example with the elevated spire and the low-spired shell from the midden.

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SEXUAL BEHAVIOR OF THE OYSTER DRILLS: EUPLEURA CAUDATA AND UROSALPINX CINEREA[1]

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The observations reported herein are part of an extensive study of the biology of *Urosalpinx cinerea* (Say), the smooth oyster drill, and *Eupleura caudata* (Say), the rough oyster drill, which is in progress at our laboratory. Results of studies of other aspects of the behavior and ecology of these predatory snails will be reported as they become available.

Little is known of the copulatory behavior of dioecious marine gastropods. Though Stauber (1943) reported a partial pairing of *E. caudata,* pairing of *U. cinerea* has never been described. Our studies show that pairing of both species is a complex process involving fairly intricate behavior of both sexes.

Copulation of Eupleura caudata. According to Stauber's (1943) description of a partial mating of *E. caudata* the male mounted the right side of the female and formed the anterior part of his foot into a copulatory groove through which the penis was ex-

[1] Contributions from the Virginia Fisheries Laboratory, No. 00. This research was conducted under contract with the U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, No. 14-19-008-2372, Study of Oyster Drills in Chesapeake Bay.

[2] Present address, Bureau of Commercial Fisheries Biological Laboratory, Milford, Connecticut.

tended into her mantle cavity. Even though disturbed repeatedly this pair copulated intermittently for 21 days. Our laboratory observations of pairing of captive *E. caudata* confirm and enlarge upon those of Stauber. Eighty-one separate pairings were observed but because the average time each couple was together was extensive and coitus occurred intermittently, only two copulations were seen from beginning to end.

Prior to coupling, the female usually moved about the aquarium walls and finally assumed a stationary position with her siphonal tip upward. Pairing also occurred in horizontal positions on oysters, or on the aquarium bottom, or rarely, on the walls. The mantle cavity was then exposed by allowing the shell to hang down and away from the posterior part of the foot. Though in most cases a male (or males) had already assumed a position upon the shell of the female, several unpaired females also exposed their mantle cavities in the same fashion prior to copulating and probably this behavior is normal precopulatory activity. Following this the male often moved about on the female's shell for a short time but eventually assumed a stationary position on her right ventral surface slightly posterior to the mantle cavity with his siphonal cavity pointing in the same direction as hers (Fig. 1, p. 6). The foot of the male extended to the rim of the mantle cavity and a copulatory groove formed in its anterior surface through which the penis was protruded into the mantle cavity and presumably the vagina, though that orifice was always hidden from view by the shell. On termination of copulation, the female often twisted from side to side and opened and closed the cavity opening. Similar twisting behavior has been observed in other gastropods apparently attempting to dislodge predatory snails, *Odostomia,* from their shells (Allen, 1958). The male then withdrew and either remained in position or moved about on the shell of the female or to the substrate.

E. caudata usually remained in position and copulated intermittently for extensive periods, often up to 48 hours. Two pairs copulated continuously for 2 hours 45 minutes ± 15 minutes and 3 hour 39 minutes ± 10 minutes, and a third for 5 hours ± 10 minutes, but all were paired longer. Another pair copulated intermittently for a total of at least 8 hours 48 minutes over a period of two days, during which the male maintained his posi-

tion on the female. A marked pair copulated 11 times in five months. During this period the pair often separated and the female paired with other males.

Eupleura caudata showed marked promiscuity. Of 29 marked pairs, 12 females copulated with more than one male and 15 males with more than one female. One male copulated with 6 different females and one female accepted 5 males throughout the season. Although these are observations on drills confined in running-water aquaria and cages, there is little reason to doubt that, depending on density and movement, similar promiscuity occurs in nature.

Usually, males were smaller than their consorts (48 males: mean height 18.7 mm., range 14.9-23.5 mm., standard deviation 2.3; 44 females: mean height 22.6 mm., range 17.5-28.9 mm., standard deviation 3.2).

Seasonal periodicity of copulation was determined in outside cage experiments and running-water aquarium observations. Though the frequency of observation was not always constant throughout the year, the number of pairings seen in aquaria per month roughly corresponded to those in more careful cage experiments. In 1956 pairings were recorded as follows: March-6, April-14, May-15, June-3, July-9, August-1, September-1, October-9, November-1, and December-1. The first occurred on March 7 (12.9°) and the first peak occurred in late April and early May. A second peak came in July, comparatively few pairings occurred from July through September, but an increase took place in the last part of October. Copulation ceased after December 10 (10.3°C). The lowest temperature at which pairings were observed was 10.3°C, the highest 28.4°C. Also in 1956, 30 females and 30 males, caged in a single large compartment, were examined every two days between 1400 and 1700 hours. Onset of the mating period was not observed because the experiment was established too late in the season. Pairing was first seen in late April at 13.7°C, reached a peak on June 7 at 23.7°C, and ceased on July 7 at 26.1°C, (Figure 3). A late wave of 28 pairings, about one-third as intense as the spring wave, began at the end of September (21.7°C) and ended November 11 (16.4°C.) Observations made two or three times a week during the winter of 1956-57 revealed no copulatory activity but this was expected because all other

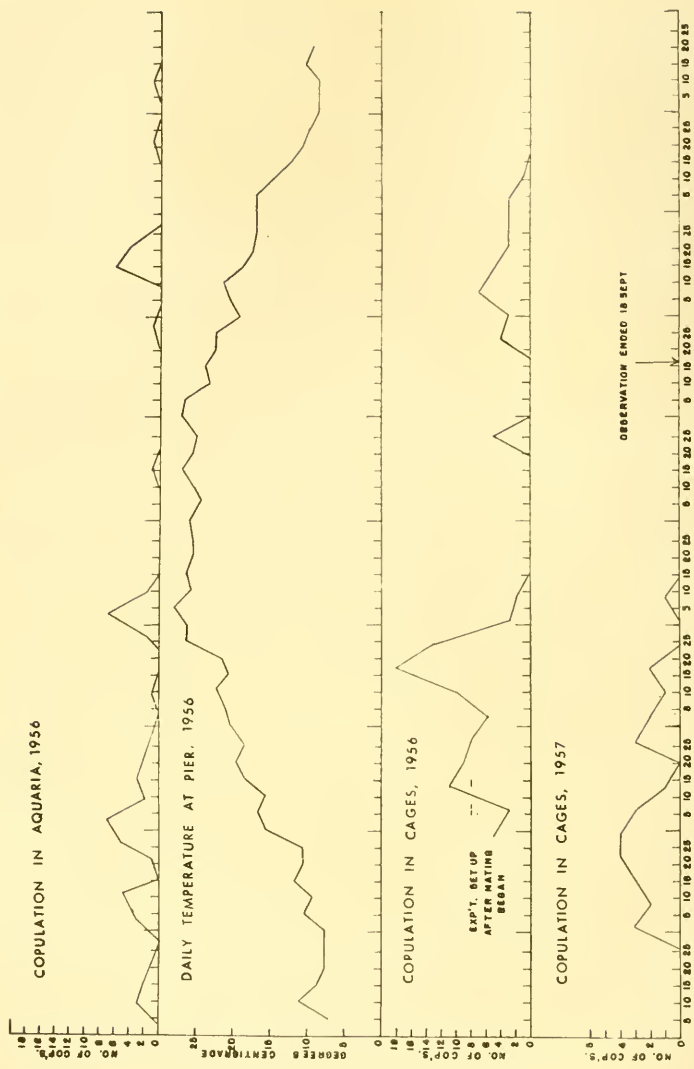

FIGURE 3. SEASONAL COPULATION OF E.CAUDATA

overt activity had ceased. Observations in the first half of the summer of 1957 on two cage compartments containing 45 specimens each (sex ratio of entire sample, 50 females to 40 males) indicated that copulation was less intense than in 1956. Pairing was first observed on April 4 (11.1°C). There was no distinct peak

and after the week of May 6 activity slowed and ceased on July 6 (26.1°C). Most activity occurred slightly earlier than in 1956, probably as a result of earlier warming. No observations were made in late summer.

Little diurnal periodicity was noticed and nocturnal activity was not investigated. Of 56 pairings, 23 (48 per cent) were completed before 1200 hours and 29 (52 per cent) occurred after 1200 hours. Because observational effort varied somewhat these data are not precise, though they are probably indicative of general conditions and comparable to those pertaining to *U. cinerea* gathered in similar fashion, see below.

On two occasions, pairs of males were observed *in copula*. Careful external examination and studies of gonad smears showed all four animals to be normal males with no detectable female characteristics. Five trios *in copula,* each composed of a female and a male in the usual position with an extra male in copulatory position on the first male, were also observed in aquaria. The extended penes of both males were seen twice. Usually the male next to the female copulated with her while the intromittent organ of the second male extended into the mantle cavity of the first, but at times both males attempted copulation with the female (Fig. 2, p. 6). Copulations involving two functional males, the middle one acting as both male and female, and another female has been reported for the hermaphroditic species, *Lymnea stagnalis,* (Crabbe, 1927) but never for dioecious gastropods. Once a quartet with 3 males, all situated chain-fashion on a female, was observed. The penes of at least two of these males were extended into the mantle cavity of the animal before them. In dioecious animals, like drills, these aberrant copulatory groups have little reproductive significance, but seem to support the hypothesis of exocrine stimulation or attraction of males to females. Possibly the males were attracted to the females, or to each other, by release of female exocrine in the vicinity and, without being able to discriminate further, established and maintained contact with each other.

Copulation of Urosalpinx cinerea. Observations of 76 pairs of *U. cinerea* showed their copulatory behavior to be generally the same as that of *E. caudata,* but with several distinct differences. The female usually assumed a stationary position with her

siphonal tip upwards, allowed the shell to fall away from the substrate, thus exposing the right rear corner of the mantle cavity and twisted the shell from side to side several times in a sort of "precopulatory dance." Most often a male was already on the female's back when this precopulatory play was observed, but several times males appeared to be attracted from afar to the demonstrating female. Sometimes unattached males, often several at a time, were attached to a demonstrating female or copulating pair, possibly drawn to the receptive female or the pair by some stimulus, probably an exocrine. Following the precopulatory demonstration by the female the male assumed a position on her right ventral side, formed a copulatory groove of the anterior portion of his foot and inserted his penis through the groove into the female's mantle cavity. On completion of coitus, the intromittent organ was withdrawn, and in contrast to the slow separation or intermittent resumption of *E. caudata,* the male moved quickly away. The shortest complete copulation observed lasted 4 minutes, the longest 32 min. Including preplay time, one complete pairing occupied one hour and 25 minutes, but actual copulatory contact required only 11 minutes. Usually *U. cinerea* copulation occupied only 3 to 4 minutes. This characteristic short contact, seldom more than 4 or 5 minutes, probably explains why *U. cinerea* mating has not been previously reported.

According to our observations, only one pair of 20 marked pairs recopulated and the pairings were 1½ months apart. Of the marked pairs 7 males and 2 females coupled with different mates. Thus, *E. caudata* seemed more promiscuous than *U. cinerea.* However, the incidence of promiscuity in *U. cinerea* may be actually greater than these data indicate because of the unlikelihood of observing its brief sexual contacts as readily as the much longer ones of *E. caudata.*

The male is usually the smaller of the pair: 41 pairing Seaside (from the ocean coast of the Eastern Shore of Virginia) males averaged 29.8 mm. in height, range 19.5-38.7, standard deviation 5.1; 46 females averaged 34.4 mm. in height, range 21.9-44.6 mm., standard deviation 4.7; six York River males averaged 19.3 mm. in height, range 16.5-24.6 mm. and five females averaged 19.5 mm. (17.3-21.2 mm.).

Pairing was seen in late October and early November, 1955,

until the temperature dropped to 13.7°C. In 1956, it began on February 29 (8.2°C., increased in March with 10 pairings, reached a peak in April with 17 pairings, and diminished in May to three pairings (20.3°C). Pairing was not observed again until October, (20.8°C), none in November and 2 on December 7 (11.5°C). Of 59 pairings, nine (15 per cent) were observed before 1200 hours and 50 (85 per cent) after 1200 hours. In contrast to *E. caudata, U. cinerea* seems to exhibit marked preference for the afternoon.

Two pairs of structurally normal males were observed *in copula* and, on another occasion, two males were observed copulating with one female.

Sperm viability and storage. One *U. cinerea* male, forcibly separated from a female, exuded sperm in a continuous, viscous stream, thus indicating that discrete spermatophores are probably not employed. Examination of seminal receptacles of at least 50 females of both species support this conclusion. Seminal receptacle smears of two females taken immediately after copulation contained immotile sperm while those in another were motile; therefore, it is not clear whether the sperm are immotile when passed. Microscopic examinations of seminal receptacles of several hundred individuals of both species revealed that many mature females contained fully or partially motile sperm at all times of the year though the sperm in some were entirely immotile. Whether they are stored in the motile condition is not clear because the mechanical action of smearing may have stimulated the sperm to activity. Apparently spermatozoal energy is sustained in some way, either through conservation of energy by immotility or special nourishment because both species can store viable sperm for considerable periods of time.

Stauber (1943) reported that a *U. cinerea* female isolated from April to October of the same year deposited egg cases containing viable embryos through the period. In our experiments 4 females isolated in November and December of 1955 produced viable eggs the following spring and summer. Of these, one deposited in May after 5 months, two spawned in August, after somewhat less than 9 months, and one in September after 9 months. Two post copula *E. caudata* females isolated in 1955 produced egg cases through 1956 and into 1957, but the embryos produced in 1957

did not develop. Unless parthenogenesis occurred—which is most unlikely—or the so-called "embryos" included in these 1957 egg cases were merely unfertilized ova and not really embryos at all, the sperm must have been vigorous enough to affect fertilization even after a storage period of over 14 months. In any case, however, the embryos (or unfertilized ova) produced in 1957 failed to develop even though handled in the same fashion as others which survived. Eight other females, isolated in late fall or early winter of 1956 produced viable cases for periods of at least six months after isolation.

Discussion. Several points of biological interest have arisen during the present study. Because of the nature of the photo receptive organs it is doubtful, but not certainly so, that the precopulatory "dance" or movements of the female attracts the male. More feasible is the chemical stimulation of the male by the female. If female oyster drills actually attract males during their "premating ritual" by release of an exocrine, such a chemical might be useful as an experimental or control tool because it is probably highly specific and powerful enough to be effective in extreme dilution.

It has been shown that females of both species are able to store sperm in their seminal receptacles for extensive periods. The mechanisms by which they are sustained should be of interest in studies of cell culture and nutrition.

Oyster drills are promiscuous and have the facility for sperm storage; therefore, unless sperm from previous pairings are discarded or resorbed completely before another mating occurs, a female contains viable sperm from several different males in her seminal receptacle. Under these circumstances, embryos produced therefrom might have different paternal hereditary materials. Thus, differences in rate of embryonic development, time of hatching, appearance, etc. may be due to varied paternity and not the usual genetic difference found among siblings. Until the precise nature of sperm storage, syngamy and egg case formation is understood, experimenters working with drill embryos cannot safely assume that all embryos in a unimaternal cluster or even a single egg case are of the same parentage.

Summary

1. *Eupleura caudata* and *U. cinerea* exhibited fairly complex

mating behavior involving definite precopulatory movement patterns by the female, stimulation of nearby males, possibly by exocrine activity, assumption of relatively constant copulatory positions by both sexes and copulatory groove formation by males. Females often twisted violently immediately prior to cessation of copulation.

2. *Urosalpinx cinerea* completed copulation in a matter of minutes, but *E. caudata* often persisted intermittently for days, remaining in position all the while.

3. *Eupleura caudata* was apparently more promiscuous than *U. cinerea* but possibly this disparity may have been a function of a species different in frequency of a pairing, *i.e.,* if *E. caudata* normally pairs more often, its comparative incidence of promiscuity would naturally be greater. Or, it may also have been a function of the length of time that pairing consumes. For example, *E. caudata* pairing takes much longer than *U. cinerea* (12 to 20 hours vs. 3 to 4 minutes or up to 200 times longer); therefore, *U. cinerea* copulation would more easily be overlooked, resulting in a numerical bias in favor of *E. caudata* in any comparison of frequency of pairing.

4. Though *U. cinerea* paired at lower temperatures than *E. caudata* (8.2°C vs. 10.2°C), mating activities of both increased during April. *U. cinerea* ceased copulatory activity in June while *E. caudata* persisted through the first week in July before stopping temporarily. Both resumed mating activities in September which increased in October, diminished in November and ceased altogether in early December.

5. In our laboratory aquaria, *U. cinerea* copulated more frequently in the afternoon and evening while mating activities of *E. caudata* were more evenly distributed throughout the day.

6. Females of both species stored viable sperm in their seminal receptacles for periods of at least 6 to 9 months.

7. Several items of general biological interest, sperm nutrition and multiple paternity of embryos within a single egg case, etc., have been discussed.

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NOTES ON VALVATIDAE FROM EARLY TERTIARY OF SOUTH AMERICA, WITH A NEW SPECIES

By J. J. PARODIZ

The living *Valvatidae* are widely distributed in the northern hemisphere, with only two species known south of the equator in New Caledonia. Fossils are known from the Jurassic and Tertiary of the Old World, as well as from the Pliocene of California and Pleistocene of central United States. The Neotropical region has three species described from Guatemala and one from Jamaica.

However, from South America, where living species of *Valvata* are unknown, C. H. Fritzche in 1924 (1) described several fossil forms, discovered by the geologist G. Steinmann in very early Tertiary strata (Puca Formation) of Bolivia and N.W. Argentina. These are:

Valvata humilis Fr. (op.cit p.23, pl.II, f.6), limestone of Miraflores, near Potosi, Bolivia.

Valvata yaviana Fr. (p.23, pl.II, f.7), and *V. satira* Fr. (p.24, pl.II,f.8), limestone of Yavi, N. of province of Jujuy, Argentina, close to the Bolivian border.

According to the original descriptions and figures, there are very little specific differences among Fritzche's forms, without sculpturing or carination, and no indication to which of the present subgenera they may be related, but all seem to be of regular planorboid shape as in *Valvata* s.s., differing also from *V. guatemalensis* Morelet or *strebeli* Cross. and Fisch.

A very different form, found in strata of southern regions but same relative age, presents the characteristic strong keel recalling the subgenus *Tropidina*. It was previously an unknown taxonomic element in the extinct Patagonian fauna, and belongs to a new species, as follows:

VALVATA WINDHAUSENI new species. Pl. 1, figs. 1-6

Shell very large, with almost 5 whorls (the last portion of the

body whorl not completely preserved), increasing regularly, and very convex, but at middle zone of the last whorl an angulosity is marked by a strong carina or marginate keel, which starts at the end of the suture, above the apertural angle; below the keel, the body becomes convex again. The best preserved portions of the last two whorls, are conspicuously marked with oblique striae very regularly spaced (approx. 0.4 mm. apart), also visible on the base of the shell. Although partially covered with a hard calcareous matrix, a wide umbilical area is observed. The median altitude of the last whorl, from suture to keel is about the same as the rest of the spire, and the altitude of the shell is almost equal to its width. The apex, well preserved, is rather obtuse.

Dimensions: total height 6 mm.; height from apex to carina 4.5 mm.; maj. diam. 8.5, min. diam. 7.5 mm.

Holotype*, and 4 paratypes, from Nahuel Niyeu (25 miles W. of Valcheta), Rio Negro province, Argentina, in lacustrine deposits of the Jahuel Formation (Windhausen 1918), of Danian age (Paleocene); collector Dr. R. Wichmann 1923 (2).

The species is named in memory of Dr. A. Windhausen, who contributed greatly to the knowledge of the Cretaceous-Tertiary boundary stratigraphy in Patagonia, and its fossils.

The smaller paratype, is a well preserved inner cast, crystallized by infiltration of silica solution, a characteristic of many of the fresh-water fossils found in these strata. This silicification is also present in the apex of the holotype. The other paratypes are larger than the holotype, showing the carina, filled with tuffaceous matrix, and deformed by lateral pressure, probably due to the strong diastrophism which subsequently affected the sediments during the Tertiary.

The area where the specimens were found, south of the Rio Negro River, corresponds to a great depression in the territory, partially filled with lacustrine and tuffaceous sediments, parallel, and sometimes mixed, or underlying, with the Roca marine beds (3), covering in unconformity the Senonian substratum. From this area also, an abundant fresh-water fauna is known, with *Diplodon bondenbenderi* D-J., *Physa doering* D-J., *Physa wichmanni* Parodiz, several pleurocerids under the old name of "Melania", *Lioplacodes,* and others (4). This fauna shows resemblance with that of Upper Cretaceous and Lower Tertiary of western United States.

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* Type and paratypes in Museo Argentino Nat. Ciencias and Carnegie Musuem respectively.

This new species is the only well carinate *Valvata,* fossil or living, known from the Neotropical region. To assign it to the subgenus *Tropidina,* on account of its strong keel, might be, however, a taxonomic risk. The apex is not flattened but somewhat elevated, as in *Pleurovalvata,* although the spaced radial striae are very different from the coarse rib-like lamellae of that subgenus, and the general outline, on the other hand, resembles *Cincinna.* By all these combinations of features, *V. windhauseni* cannot be restricted to any of the known subgenera. *Valvata* is a genus very plastic to the enviroment, and Haas (5) reached the conclusion that lacustrine habits are in someway related with sculpturing in fresh-water mollusks and, in the case of *Tropidina,* the presence of a keeled sculpture is probably due to a genotypic feature acquired during prolonged lacustrine life and become invariable. For very variable living species, as *V. utahensis,* Morrison (6) questioned if the specimens should be distributed in thirds to the subgenera *Cincinna, Pleurovalvata* and *Tropidina,* or should one disregard these names as long as they are based on superficial characters only.

Notes and references

(1) C. H. Fritzche, Neues Jahrb. fur Min. Geol. und Palaont., *50*:1-56, taf.1-4, Stuttgart 1924. Paper continues on pages 313-334 about older fauna which are of no concern here, but the explanations of plates all on pag. 334.

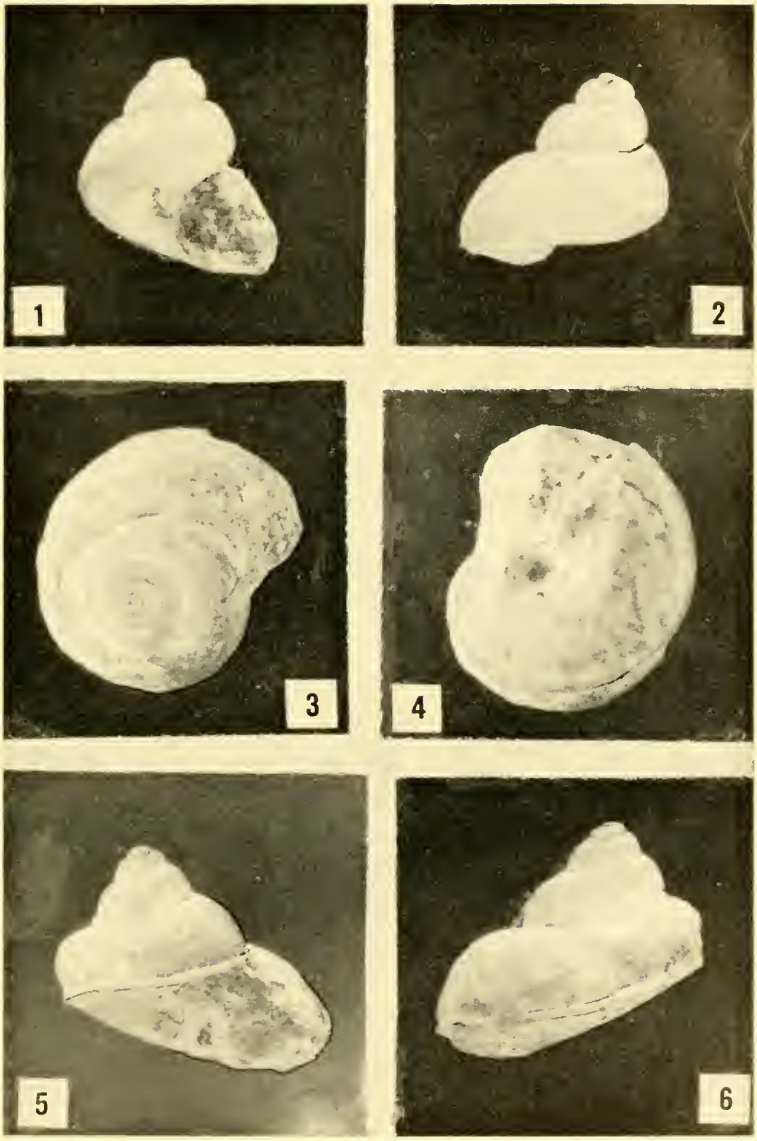
(2) R. Wichmann, 1927, published an account of this stratigraphic series: Boletin Academia Nacional Ciencias, Cordoba, *30*:384-407. Recent studies proved that the molluscan fauna is Danian.

(3) Roca (Rocanean or "Rocanense") now considered as northern member of San Jorge Formation (Montian), and it is synchronic with Puca Formation of Peru and Bolivia (with *Valvata*) which Fritzche formerly placed in the Upper Cretaceous. See also references to other fresh-water mollusks of the Puca Formation in H. A. Pilsbry, John Hopkins Univ., Studies in Geol. *13*:69-72, 1939; and F. Ahlfeld, Revista Museo La Plata (Geol.) 3:1-370, 1946.

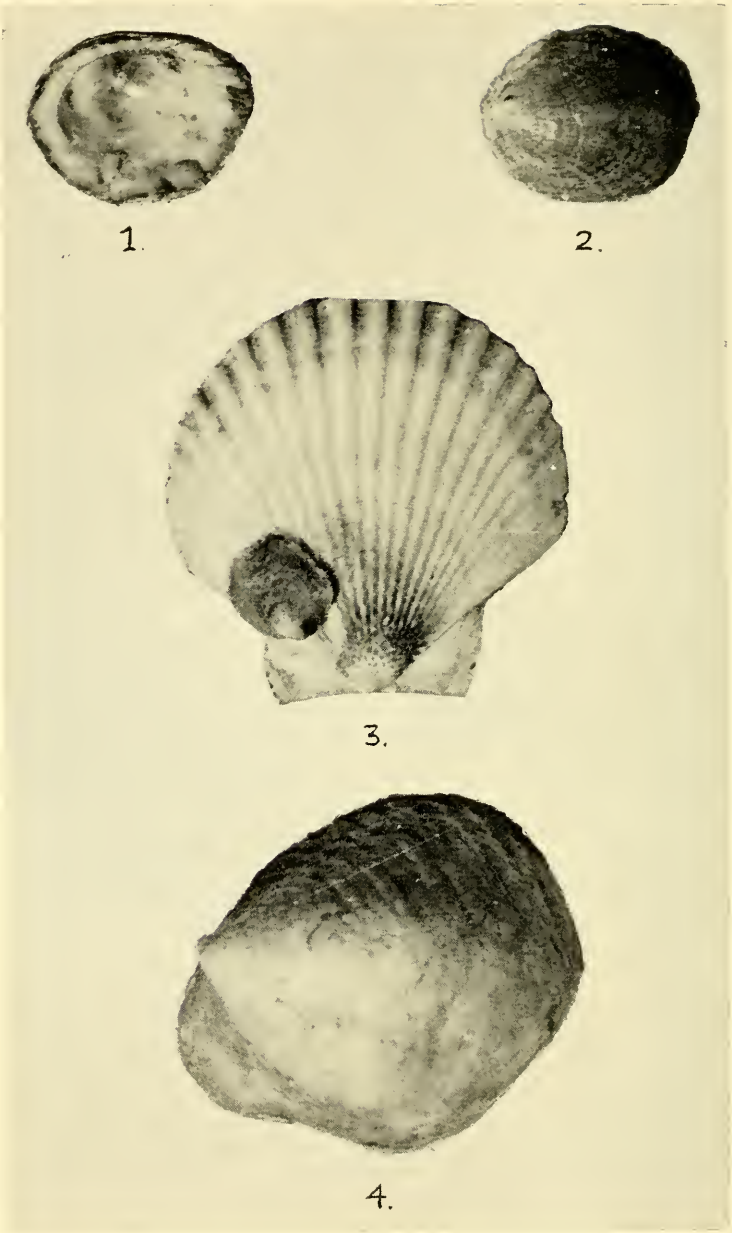
(4) See M. Doello Jurado, Bol. Acad. Nac. Cienc. Córdoba, *30*:407-416, 1927.

(5) F. Haas, Zool. Ser. Field Museum Nat. Hist., *24,* No. 8, 1939.

(6) Naut. *53*:140, 1940.



Valvata windhauseni Parodiz, from type lot. Figs. 3 to 6, holotype.



Capulus sericeus Burch & Burch. Figs. 1 & 2, holotype, ventral and dorsal views. Figs. 3 & 4, additional examples, mentioned in text

A NEW CAPULUS FROM GULF OF CALIFORNIA

By JOHN Q. and ROSE L. BURCH

Among other interesting species taken on the Ariel Expedition to the Gulf of California, Aug. 30 to Sept. 6, 1960, were several specimens of a species of *Capulus* which appears to be new.

CAPULUS SERICEUS, new species. Plate 2.

Shell cap-shaped, oval; apex spiral, turned towards the posterior side, curling downwards, and twisted to the left as in some species of the genus *Crepidula*; aperture transversely oval, with an irregularly sinuated margin, the posterior expanded; exterior surface with definite and distinct axial and radiating raised lines, a velvety periostracum extending beyond the margins; interior rose color with darker rays extending from the apex to the anterior margin; shell not symmetrical but modified in shape by its sessile habit conforming to the surface on which it is attached; growth marks conspicuous but irregular. Length of holotype 14.8 mm.; width 12.3 mm.; height 6.3 mm.

This new form was taken commensal on *Pecten sericeus* Hinds, 1845. It is obviously related to *Capulus californicus* Dall of California, which is commensal on *Pecten diegensis* Dall, but differs from that species in the sculpture of the exterior surface and the color and rays of the interior. The axial lines are much more pronounced than are those on *Capulus californicus* Dall, and the radial lines are much more prominent. The periostracum on *Capulus sericeus* is much more like overlapping shingles than on *Capulus californicus* Dall, which seems to be nearer to *Capulus ungaricoides* (Orbigny) in that it is smooth under the periostracum. On *Capulus californicus* Dall, the radiating lines are not as uniform, but seem to be more as irregularities in the shell due to conformation to the host shell. A study of the protoconch shows little variation in species, all being of the same general form, but a comparison indicates that *Capulus sericeus* has a more sunken protoconch. *Capulus sericeus* resembles *Capulus hungaricus* Linnaeus, type species of the genus, in having radiating raised lines, but lacks the fine ribs that radiate from the apex toward the margin in the latter species. The only other species described from the eastern Pacific is *Capulus ungaricoides* (Orbigny, 1841), type locality, Payta, Peru. Orbigny described his species under the name *Pileopsis* Lamarack, 1812 which is in the synonymy of *Capu-*

lus Montford, 1810. This species is smooth except for radiating raised lines on the periostracum. We wish to thank Dr. S. P. Dance, British Museum (Natural History) for his advice that *Capulus ungaricoides* (Orbigny) does not seem to him to be the same species. In addition to the shell characters mentioned above, we are convinced, from a study of ocean currents, that it is unlikely that this occurrence constitutes a range extension from Peru. *Capulus chilensis* Dall, 1904, from the Antarctic, is possibly a species related to *Capulus ungaricoides* (Orbigny).

The type specimen (pl. 2, figs. 1 & 2) was trawled off Cabo Haro, near Guaymas, Sonora, Mexico at a depth of 100 fathoms, and will be deposited in the Stanford University Type Collection, no. 8519. This specimen is from the collection of Dr. Homer King.

Other specimens here named paratypes are: one specimen trawled off Cabo Haro, Sonora, Mexico in 20-40 fathoms, Dec. 27, 1959 on the ship General Yanes, collection of Dr. Donald Shasky; one specimen trawled off Cabo Haro, Sonora, Mexico, collection of Mr. Mark Rogers.

The following are mentioned as hypotypes, all from the Gulf of California, but not the type locality; one specimen trawled off Espiritu Santo Island in 40-90 fathoms, fig. 3, collection of Dr. Donald Shasky; one specimen trawled off Monserrate Island in 20-40 fathoms, Sept. 1, 1960, fig. 4, collection of Dr. Donald Shasky; one specimen trawled off Monserrate Island in 75 fathoms, collection of Mr. Mark Rogers.

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A SECOND WESTERN ATLANTIC RISSOELLA AND A LIST OF THE SPECIES IN THE RISSOELLIDAE

By ROBERT ROBERTSON

(Concluded from April no.)

Genera, subgenera and species in the family Rissoellidae

The genera and subgenera *Lacunella* (family Lacunidae), *Fairbankia* (Micromelaniidae), *Hyala, "Dardania"* (=*Dardanula), Tatea* (Rissoidae), and *Diala* (Cerithiidae) have, at one time or another, been wrongly included in the Rissoellidae by various malacologists. Some of the species listed below (notably those named by A. Adams and W. H. Turton) probably are also not rissoellids. All species originally named as rissoellids are included in the list, as well as species which have been rightly or wrongly transferred to rissoellid genera.

albella, Rissoa. Alder (1844). See also Thompson (1844). An older name for *R. glabra* Alder non Brown than *R. diaphana.* The name *R. albella* Alder never has been adopted and the "50 year rule" is here invoked to suppress it (I.C.Z.N. ruling pending).

alderi, ?Jeffreysia. Carpenter (1856). "Mazatlan" [W. coast Mexico]. According to Bartsch (1920) a *Barleeia* (Rissoidae). See also Baker, Hanna & Strong (1930).

anguliferens, Rissoa. Folin (1869). "Baie de Panama." Referred by Bartsch (1920) to *Rissoella.*

atlantica, Jeffreysia. Smith (1892). "St. Helena."

bakeri, Rissoella (?). Strong (1938). "9 to 15 fms. off Guadalupe Island, Mexico."

becki, Jeffreysia. Turton (1932). "Port Alfred, South Africa."

bifasciata, Jeffreysia. Carpenter (1856). "Mazatlan" [W. coast Mexico]. See Bartsch (1920).

caffra, Rissoa (Cingula). Sowerby (1897). "Port Elizabeth" [South Africa]. Referred by Bartsch (1915) and Turton (1932) to *Jeffreysia.* Specimens collected by Turton at Port Alfred (M.C.Z. 101515) are not rissoellids.

californica, ?Rissoella. Bartsch (1927), "San Clemente Island, California."

capensis, Rissoa (Cingula). Sowerby (1892). "Port Elizabeth" [South Africa]. Apparently this is the species referred by Bartsch (1915) to *Jeffreysia.* See Turton (1932).

caribaea, Rissoella (Phycodrosus). Rehder (1943a). "Bonefish Key, Fla." [One of the Crawl Keys between Grassy Key and Vaca Key, Florida Keys.]

cylindrica, Jeffreysia. Jeffreys (1856). ". . . in about 12 fathoms at Spezia" [Italy]. Referred by Monterosato (1878) to *Aclis*

(Aclididae). Specimens from Sicily (A.N.S.P. 247781), which presumably are correctly identified, have hyperstrophic protoconchs and are pyramidellids.

diaphana, Rissoa? Alder (1848. New name for *R.? glabra* Alder non *R. glabra* (Brown). Referred by Forbes & Hanley (1850) to *Jeffreysia* and incorrectly by Clark (1850) to *"Chemnitzia"* (Pyramidellidae), who claimed, wrongly, that the apex is reflexed (i.e., hyperstrophic); see Jeffreys (1851) and Alder (1851a). See *albella* and *nitidus.*

duperrei, Paludestrina. Vélain (1877). [Misspelled *'Duperei'* p. 144.] "Ile Saint-Paul; dans l'ouest du banc Roure, par les fonds de 35 mètres a 50 mètres." [S. Indian Ocean]. Referred by Thiele (1912) to *Jeffreysiopsis.*

eburnea, Rissoa. Stimpson (1851a, b). ". . . in thirty fathoms, off Cape Ann" [Massachusetts]. Doubtfully and wrongly referred by Gould (1870) to *Rissoella.* An *"Odostomia"* (Pyramideliidae); see Bartsch (1909).

edwardiensis, Jeffreysia. Watson (1880). [Challenger] "St. 145*a* . . . Lat. 46° 41′ S., long. 38° 10′ E. Prince Edward Island, between Cape of Good Hope and Kerguelen. 50 to 150 fms." Figured Watson (1886); possibly from 310 fms., or from Sta. 145. Referred doubtfully by Thiele (1912) to *Jeffreysiella,* and definitely by Iredale (1912) to *Heterorissoa.*

excolpa, Rissoella. Bartsch (1920). "Concepcion Bay, Lower California" [Mexico]. See Baker, Hanna & Strong (1930).

fulgida, Rissoella. "A. Ad." Dunker (1882). [Japan].

fuscotincta, Jeffreysia. Turton (1932). "Port Alfred, South Africa."

galba, Rissoella. Robertson, this paper.

glabra, Rissoa?. Alder (1844). "Dalkey Island near Dublin [Ireland], and at Cullercoats, Northumberland [England]." A misapplication of the name *Rissoa glabra* (Brown) Brown (1844), a pyramidellid. *R. glabra* Alder referred to *Rissoella* by Gray (1847). Weinkauff (1868) wrongly referred *R. glabra* (Brown) to *Jeffreysia.* See *diaphana.*

globularis, Jeffreysia. "Jeffreys, MS." Forbes & Hanley (1852). ". . . at Skye [Scotland] and the Shetlands . . ." Figured (1853).

gulsonae, Chemnitzia. Clark (1850). ". . . prope ostia Iscae Danmoniorum." [Exmouth, England]. Referred doubtfully by Jeffreys (1851) to *Jeffreysia* and later (1867) to *Aclis.* Type species of *Pherusina* (Aclididae).

hera, Jeffreysia. Turton (1932). "Port Alfred, South Africa."

hertleini, Rissoella. Smith & Gordon (1948). "10 fathoms . . . off Cabrillo Point, Monterey Bay, California."

Heterorissoa Iredale (1912). Type species (original designation): *H. secunda.* Synonym of *Jeffreysiella* according to Thiele (1925).

hydrophana, Rissoella. A. Adams (1860). "Tabu-Sima [Tobi Shima]; 25 fathoms" [Japan].

indistincta, Jeffreysia. Turton (1932). "Port Alfred, South Africa."

inflata, Jeffreysia. Monterosato (1878). Nom. nudum. "Pal. [ermo] e Trap. [ani] (Monts.); Messina (Granata)." [Sicily].

Jeffreysia Alder in Forbes & Hanley (1850). Type species (original designation): *J. diaphana.* Objective junior synonym of *Rissoella.*

Jeffreysiella Thiele (1912). Type species (original designation): *J. notabilis.*

Jeffreysilla Thiele (1925). Type species (monotypy): *Rissoella zebra.*

Jeffreysina Thiele (1925). Type species (subsequent designation, Winckworth, 1932): *J. globularis.* Ranked as genus by Rehder (1943a).

Jeffreysiopsis Thiele (1912). Type species (here designated): *Paludestrina duperrei* Véiain. Synonymized with *Rissoella,* s.s., by Thiele (1925).

johnstoni, Rissoella. Baker, Hanna & Strong (1930). "Cape San Lucas, Lower California" [Mexico].

malayensis, Rissoella? Thiele (1925). "Station 211 . . ." [805 meters, 7° 48.8′ N., 93° 7.6′ E., near Nicobar Islands].

minima, Rissoella. A. Adams (1860). "Tsu-Sima; 26 fathoms" [Japan].

mundula, Rissoella. A. Adams (1860). "Tsu-Sima; 26 fathoms" [Japan].

nitidus, Turbo. J. Adams (1797). Nom. dubium. "Pembrokeshire" [Wales]. Considered by Jeffreys (1867) a possible older name for *Rissoa? diaphana* Alder.

nitida, Jeffreysia. "Sars" Friele (1876). *Hydrobia nitida* Sars (1859), nom. nudum. "Bergen" [Norway]. Close to *"Rissoella" eburnea* (Stimpson), a pyramidellid, according to Sars (1878). See *eburnea.*

notabilis, Jeffreysiella. Thiele (1912). "Observatory Bay . . . Kerguelen." [S. Indian Ocean]. See also Thiele (1925).

omphalotropis, Rissoella. A. Adams (1860). "Sado; 30 fathoms" [Japan].

opalina, Rissoa (?). Jeffreys (1848). "Guernsey and Sark" [Channel Islands]. Referred by Forbes & Hanley (1850) to *Jeffreysia* and incorrectly by Clark (1851) to *"Chemnitzia"* (Pyramidellidae; see Alder (1851b).

pauli, Rissoella. See *sancti-pauli.*

Phycodrosus Rehder (1943a). Type species (original designation): *Rissoella caribaea.* Subjective synonym of *Jeffreysilla* (this paper).

Rissoella Gray (1847). Type species (monotypy): *"Rissoa?*

glaber, Alder." [=*Rissoa? diaphana* Alder].

sancti-pauli, Rissoella [(*Jeffreysia*)]. Vélain (1877). Vélain (1876), nom. nudum. "Ile Saint-Paul . . . au niveau de la basse mer..." [S. Indian Ocean]. Emended to *R. pauli* by Crosse (1879).

secunda, Heterorissoa. Iredale (1912). "Kermadec Islands." [S. Pacific Ocean].

simoniana, Jeffreysiopsis. Thiele (1912). "Simonsbai" [probably Simonstown, nr. Cape Town, South Africa].

spiralis, Rissoella. A. Adams (1860). "Sado; 30 fathoms" [Japan].

sulcosa, Phasianella. Mighels (1843). "Casco Bay" [Maine]. Wrongly referred by Gould (1870) to *Rissoella.* An *"Odostomia"* (Pyramidellidae); see Johnson (1915).

tenuis, Jeffreysia. Turton (1932). "Port Alfred, South Africa."

translucens, ?Jeffreysia. Carpenter (1866). Carpenter (1864), nom. nudum. "S. Diego" [California]. Referred by Bartsch (1920) to *"Syncera"* (=*Assiminea,* Assimineidae).

tumens, Jeffreysia. Carpenter (1856). "Mazatlan" [W. coast Mexico]. Referred by Carpenter (1866) to *"Cythna"* (?Stiliferidae). Retained by Bartsch (1920) in *Rissoella.* See also Baker, Hanna & Strong (1930).

turgidula, Rissoella. A. Adams (1860). "Korea Strait; 46 fathoms."

vesicalis, Rissoella. A. Adams (1860). "Sado; 30 fathoms" [Japan].

vitrina, Rissoella. A. Adams (1860). "Tabu-Sima [Tobi Shima]; 25 fathoms" [Japan].

wilfredi, Jeffreysia. Gatliff & Gabriel (1911). "Ocean beach, near Point Nepean" [Victoria, Australia]. Referred by Iredale (1912) to *Heterorissoa* (misspelled *'wilfridi'*).

zebra, Rissoella. Thiele (1925). "Deutsch-Ostafrika . . . Daressalam" [Tanganyika].

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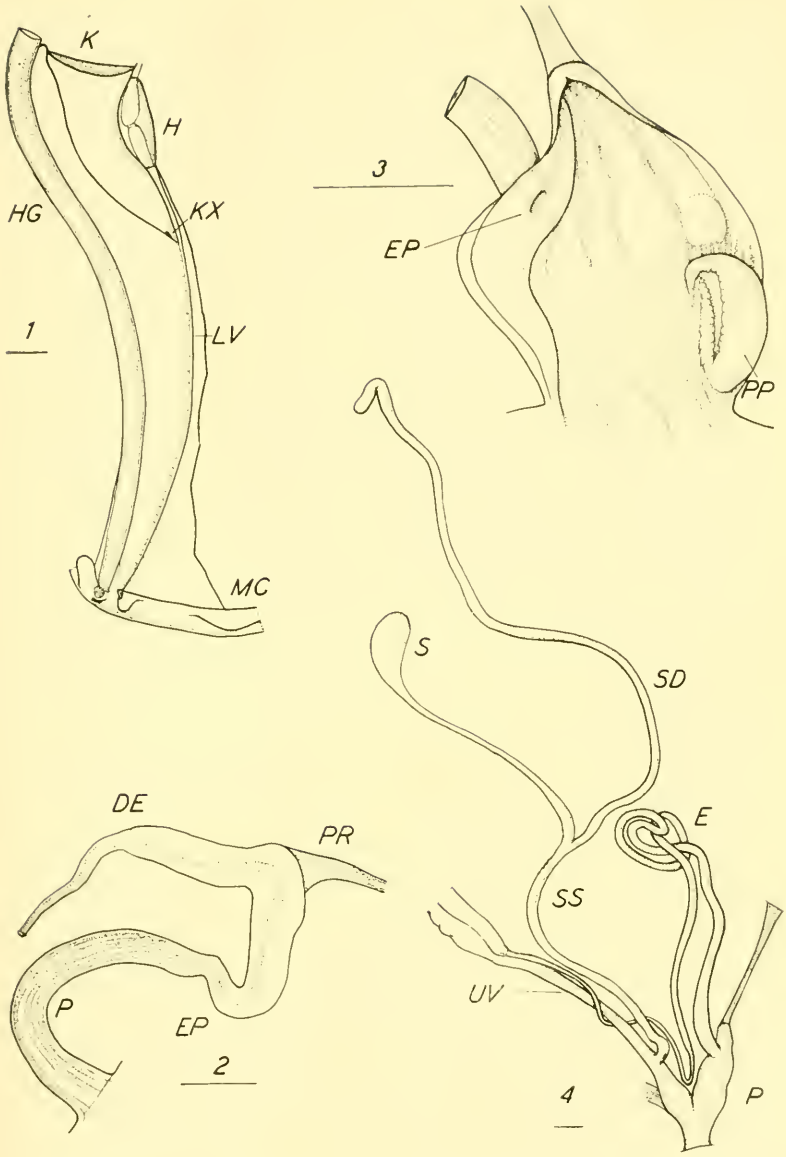
EIGHT NEW SPECIES OF LAND SNAILS FROM THE SOUTHERN UNITED STATES

By LESLIE HUBRICHT

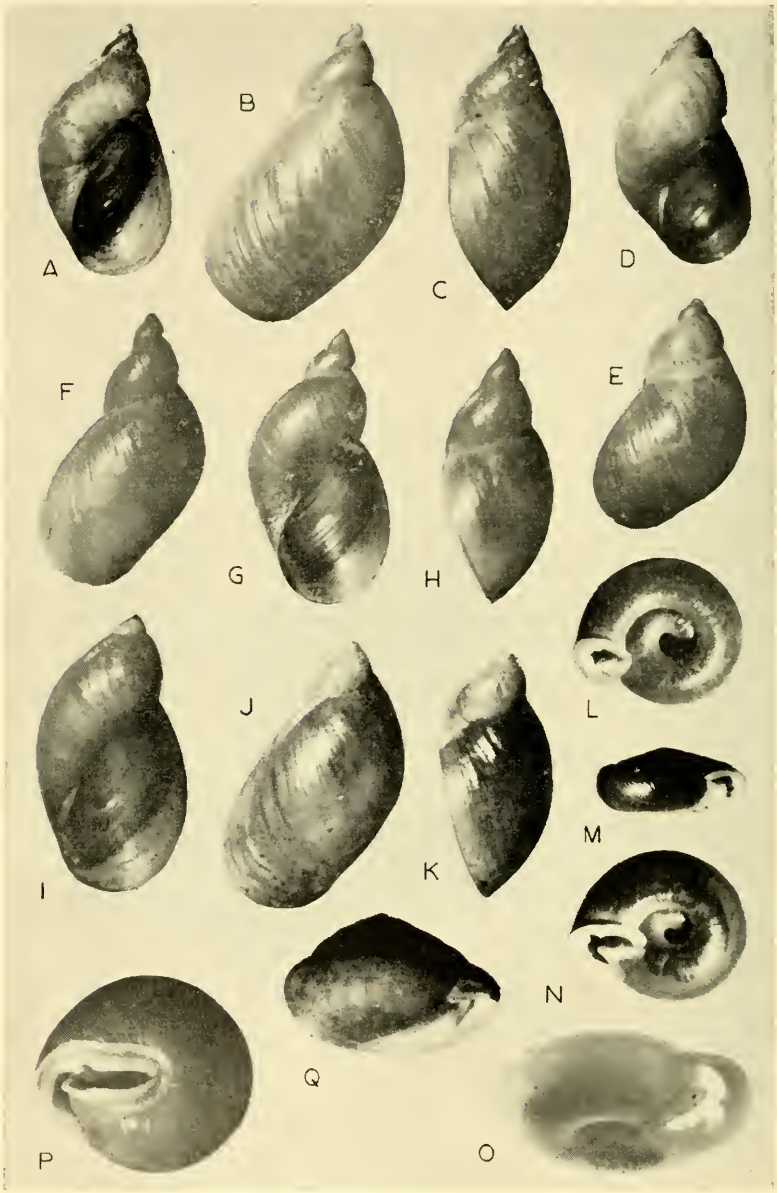
POLYGYRA GRACILIS, new species. Pl. 4, figs. N & O.

Shell pale brown, base lighter, translucent, shining, of 5 to 5.5 whorls. Spire slightly convex, of slowly increasing whorls, the last shortly descending in front; periphery above the middle, rounded. First whorl smooth, following whorls becoming increasingly striate; last two whorls weakly ribbed above, base smooth with growth lines only, or with weak ribs behind the lip. Umbilicus well-like, expanding in the last whorl to about 4 times its earlier diameter, contained about 3.5 times in the diameter of the shell; last whorl with a shallow furrow parallel to the umbilical suture. Aperture very oblique, deeply furrowed behind, outer and basal margins of lip strongly reflected, thickened within, its inner edge bearing two teeth; one on the basal margin and one on the outer margin. Ends of the lip joined by a parietal callus bearing a V-shaped tooth. A short distance within there is a callous tubercle on the columellar axis.

Height	Diameter	Whorls	H./D.
3.9 mm.	8.3 mm.	5.5	0.47 Holotype.
4.1 mm.	9.1 mm.	5.5	0.45 Paratype.
3.6 mm.	7.8 mm.	5.0	0.46 Paratype.
3.2 mm.	6.7 mm.	5.0	0.48 Medina River drift.
2.7 mm.	6.7 mm.	5.0	0.40 Nueces River drift.



Figs. 1 & 2, *Nenia tridens*. 1, internal view of pallial complex. 2, penis and accessories; optical longitudinal section of flattened mount in glycerin jelly; semi-diagrammatic. Figs. 3 & 4, *Cerion uva*. 3, penis, cut open and pinned out. 4, terminal genitalia, dissected apart. Scales represent 1 mm. Drawn with aid of camera lucida.



Holotypes: A-C, *Succinea solastra* Hubricht. D & E, *S. urbana* Hubricht. F-H, *Catinella texana* Hubricht. I-K, *C. pugilator Hubricht.* L & M, *Polygyra lithica* Hubricht. N & O, *P. gracilis* Hubricht. P & Q, *Stenotrema calvescens* Hubricht. Photographs by John B. Burch, University of Michigan.

Distribution.—*Texas*: Comal Co.: Guadalupe River bluff, 2 miles south of Sattler, holotype 205894 and paratypes 205893, University of Michigan Museum of Zoology, other paratypes 14834, collection of the author; drift, Guadalupe River, New Braunfels. Kerr Co.: 12 miles southwest of Kerrville; river bluff, 5 miles southwest of Hunt. Bandera Co.: drift, Medina River, 4.7 miles northwest of Medina. Medina Co.: Hondo. Real Co.: Frio River bluff, 5.5 miles north of Leakey. Uvalde Co.: drift, Nueces River, 7 miles west of Uvalde; drift, Nueces River, 1.5 miles south of Laguna; Garner State Park.

Polygyra gracilis is a species of river bluffs and ravines in the Edwards Plateau of Texas. It is most closely related to *Polygyra mooreana* (W. G. Binney), which is found in the same region. It differs in its more slender whorls, more depressed shape, and more glossy and translucent shell. Of the specimens measured *P. gracilis* had a height diameter index below 0.50 with an average of 0.45, while in *P. mooreana* the measured shells were all above 0.50 with an average of 0.57. The lip teeth are usually smaller and more widely spaced and are not as laterally compressed. The parietal tooth usually does not have the distinct lower angle found in *P. mooreana,* being more rounded. Despite its close relationship to *P. mooreana,* the two species could be readily separated in river drift material.

POLYGYRA TAMAULIPASENSIS Lea.

Polygyra texasiana texasensis Pilsbry, 1940, Land Moll. N. Amer. *I,* p. 619, fig. 394g, h.

Polygyra texasensis Pilsbry, Pilsbry & Hubricht, 1956, Naut. *69*: 94.

Polygyra texasiana tamaulipasensis Lea, Pilsbry & Hubricht, 1956. Naut. *69*: 95, Pl. 5, figs., 1, 1a.

This species has been considered to be a subspecies of *Polygyra texasiana* (Moricand), but is quite distinct. I have seen no intergradation in the beach drift material, nor in any material collected in west Texas. It differs from *P. texasiana* in having a more depressed shell with narrower whorls and a larger umbilicus. The shell is never banded. The parietal tooth is longer, higher and straighter, the outer end extending a little beyond the lower end of the lip. The outer end of the upper branch is enlarged into a low tooth. The animal is pale gray rather than brownish-yellow. It lives in rock piles and under prostrate yuccas on the tops of the mesas, while *P. texasiana* in west Texas lives in low ground near streams and ponds.

Polygyra texasiana is quite variable in its sculpture. Those from near the coast are often strongly ribbed above and below. Away from the coast the ribbing on the base disappears and they are only ribbed above. Farther west the upper surface becomes smooth. Within the range of *P. tamaulipasensis, P. texasiana* can not be distinguished by the sculpture. The presence of the tooth on the end of the upper branch of the parietal tooth will always separate *P. tamaulipasensis* from *P. texasiana.*

P. tamaulipasensis is found living from near Junction, Kimble Co., west to Alpine, Brewster Co. and north to Colorado City, Mitchell Co., Texas. The record from Lyford, Cameron Co., Texas is based on *P. scintilla* Pilsbry & Hubricht. The record from near Roswell, New Mexico is based on a smooth *P. texasiana.*

POLYGYRA LITHICA, new species. Pl. 4, figs. L & M

Shell depressed, pale brown, of 5 to 6 whorls. Spire weakly convex, of slowly increasing whorls, periphery rounded. Embryonic whorls smooth, later whorls becoming increasingly striate, last two whorls weakly rib-striate, rib-striae becoming much weaker below the periphery, base with distinct spiral striae. Umbilicus deep, well-like, expanding in the last whorl to about one-third the diameter of the shell. Aperture oblique, deeply furrowed behind, lip, reflected and strongly thickened, with two teeth on the inner margin, the basal tooth laterally compressed, not immersed; the outer tooth only slightly immersed, of about the same size as the basal tooth. Ends of the lip joined by a heavy parietal callus bearing a heavy tooth which is rounded in front view. A short distance within there is a callous tubercle on the columellar axis.

Height	Diameter	Whorls	H./D.
3.2 mm.	7.4 mm.	5.8	0.43 Holotype.
3.7 mm.	8.1 mm.	6.0	0.46 Paratype.
3.3 mm.	7.0 mm.	5.5	0.49 Paratype.
2.7 mm.	7.9 mm.	5.2	0.46 Rushing.

Distribution.—*Arkansas:* Stone Co.: upland oak-hickory woods, 6 miles east of Mountain View, holotype 205896 and paratypes 205895 U.M.M.Z., other paratypes 15917, collection of the author; 4 miles northwest of Allison; 2 miles northeast of Rushing.

Polygyra lithica is related to *P. dorfeuilliana* Lea, differing in the teeth. The parietal tooth is lower and is rounded rather than squarish. The lip teeth are smaller and are not deeply immersed. It is apparently a species of quite limited range, being known only from a small area in north-central Arkansas.

STENOTREMA CALVESCENS, new species. Pl. 4, figs. P & Q.

Shell buffy brown to bister, globose-conic, imperforate, of about

5.5 whorls; periphery above the middle, rounded or slightly subangular in front of the aperture. Embryonic whorls sculptured with radially elongated granules, later whorls with fine radial lines, last three whorls with numerous soft deciduous hairs. Aperture narrow, very pale brown, outer edge of the basal lip wholly adnate, inner edge with a distinct U-shaped central notch; interdenticular sinus rounded, moderately deep; there is no tooth within the outer arc of the lip. Parietal tooth rather low and slender, curved, leaning towards the basal lip. There is no buttress connecting the parietal tooth to the end of the outer lip. Edge of the parietal callus extending well beyond the parietal tooth. Fulcrum thin with slightly convex edge.

Height	Diameter	Whorls	H./D.
6.5 mm.	9.7 mm.	5.7	0.67 Holotype.
5.6 mm.	8.1 mm.	5.2	0.69 Paratype.
6.0 mm.	9.3 mm.	5.6	0.65 Paratype.
6.7 mm.	10.2 mm.	5.5	0.63 Hixon.

Distribution.—*Tennessee:* Marion Co.: Cumberland Mtn., 1 mile east of Monteagle, holotype 205898 and paratype 205897 U.M.M.Z., other paratypes A9690, collection of the author: Cumberland Mtn., 2.4 miles southeast of Monteagle; West Fork of Pryor Cove, 2 miles northeast of Jasper; under pine logs, summit of Suck Creek Mtn., 15 miles west of Chattanooga (W. F. Shay, coll.) Hamilton Co.: vacant lot, Thrasher Pike, Hixon (James R. Hood, coll.) ; near Silver Creek, 300 Signal Mtn. Road, North Chattanooga.

In the West Fork of Pryor Cove, *Stenotrema calvescens* was found associated with *S. stenotrema* (Pfr.) from which it could be readily separated by its smaller size, less reddish color, finer, more numerous hairs, and by the absence of a buttress. The hairs are found only in young and recently matured shells. They are lost in old shells. Scrubbing of the shells in cleaning will remove most of the hairs. *Stenotrema calvescens* is apparently most closely related to *S. florida* Pilsbry, from which it differs in its smaller size, larger lip notch, and finer, more numerous hairs.

PRATICOLELLA BERLANDIERIANA CAMPI Clapp & Ferriss.

Praticolella campi Clapp & Ferriss, 1919, Naut. *32:* 78, Pl. 6, figs. 1-4.

Praticolella berlandieriana taeniata Pilsbry, 1940, Land Moll. N. Amer. *I,* p. 696, figs. 427g, h.

Praticolella campi is a winter resting stage of the form later described as *P. berlandieriana taeniata* Pilsbry. It is found only in the winter and is always found associated with adult shells. It always agrees in color pattern with the adult shells found with it. Adult shells sometimes show an irregularity in the spire corres-

ponding to this resting stage. Animals dissected by both Dr. Pilsbry and myself were found to be sexually undeveloped. It is a stage in which there is a high mortality, as they are common in river drift and fossil deposits while other immature stages are rare. The name *campi* will have to replace *taeniata* for the *Praticolella berlandieriana* × *P. griseola* hybrid populations of southern Texas and northeastern Mexico.

Similar resting stages are also found in *Praticolella griseola* (Pfeiffer) and *Praticolella pachyloma* ('Menke' Pfeiffer).

SUCCINEA SOLASTRA, new species. Pl. 4, figs. A-C; text-fig. 1, B.

Shell pale buff, translucent, shining, with about 3.5 whorls, thin but firm, elongate-ovate in shape, sculpture of unevenly spaced growth wrinkles. Spire acute, moderately long, sutures well marked, periphery somewhat flattened. Aperture ovate, occupying about sixty percent of the length of the shell, outer and basal margins well rounded. Columella nearly straight.

Animal pale, mantle pale with scattered brownish spots. Hermaphrodite duct well pigmented. Talon moderately pigmented, club-shaped with two terminal lobes and a longitudinal groove down the center, giving it the appearance of being bifurcate. Prostrate gland large, irregularly oval, compressed by surrounding organs, unpigmented. Vas deferens not very long, entering the penis a little below the apex. Vagina and atrium very short. Vaginal retractor muscle long and stout. Penis rather stout, with a constriction about two-thirds the way up, above this it is somewhat inflated and free from the sheath. Penial retractor muscle thick and broad. Spermatheca globose, the duct slender throughout its length.

Height	Diam.	Ap. H.	Ap. W.	Whorls
15.3 mm.	7.3 mm.	9.7 mm.	5.7 mm.	3.5 Holotype.
16.0 mm.	7.3 mm.	9.3 mm.	5.7 mm.	3.5. Paratype.
16.0 mm.	8.7 mm.	9.7 mm.	6.3 mm.	3.5 Paratype.
11.7 mm.	6.0 mm.	7.0 mm.	4.0 mm.	3.5 Combes, Texas.
9.5 mm.	4.7 mm.	5.7 mm.	3.2 mm.	3.5 Combes, Texas.

Distribution.—*Texas:* Terrell Co.: Sanderson; 5 miles north of Sanderson; side of mesa, 5 miles southeast of Sanderson. Val-Verde Co.: Shumla. Uvalde Co.: Uvalde, Dimmit Co.: just north of Caterina; near culvert, 6.5 miles south of Caterina; near culvert, 2.5 miles northwest of Carrizo Springs. Frio Co.: culvert, 5.5 miles southwest of Moore. Bexar Co.: culvert, on US-281, 9.5 miles north of San Antonio. Live Oak Co.: near Ramirena Creek, 13 miles south of George West. Bee Co.: culvert, 2 miles south of Pettus Jim Wells Co.: Premont. Starr Co.: culvert, 6 miles northwest of Roma; 1.5 miles southeast of Rio Grande City. Hidalgo Co.: near Bentzen Rio Grande Valley State Park, holotype 205900 and paratype 205899 U.M.M.Z., other para-

types 14322, collection of the author. Willacy Co.: roadside, 0.7 miles north of Santa Monica. Cameron Co.: 6.3 miles southwest of Boca Chica; 0.5 mile northwest of Combes; dump, 3.4 miles east of La Paloma. *Mexico:* Tamaulipas: 1 mile southeast of Ciudad Mier; San Fernando. Nuevo Leon: near arroyo, 4 miles northeast of Pesqueria Chica; 32.8 miles east-northeast of General Bravo.

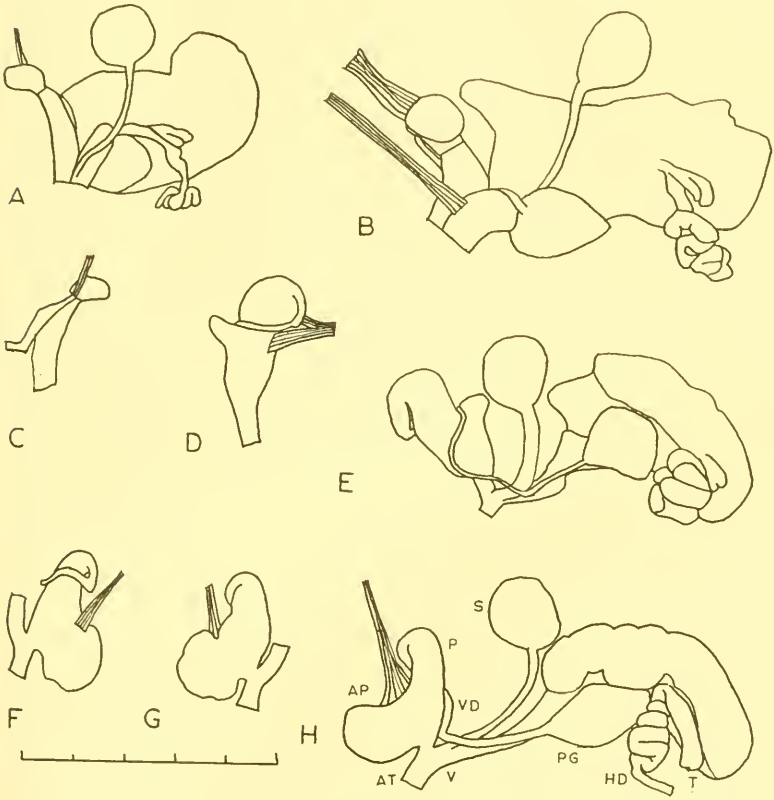


Figure 1, genitalia: A & C, *Succinea urbana* Hubricht. B, *S. solastra* Hubricht. D & E, *Catinella pugilator* Hubricht. F-H, *C. texana* Hubricht. (ap., appendix; at, atrium; h.d., hermaphrodite duct; p., penis; p.g. prostate; v., vagina; s., spermatheca; v.d., vas deferens; t., talon.)

Succinea solastra is frequently found associated with *Succinea luteola* Gould, from which it may be readily separated by the anatomical differences, its smaller size, more acute spire, and translucent shell. The shell is usually covered with dirt while that of *S. luteola* is usually clean. It is most closely related to

Succinea grosvenori which differs in its more globose, more opaque shell; and dark mantle. The genitalia are not distinguishable from those of *S. grosvenori* Lea.

An examination of many lots of anatomical material of succineids, collected over the past several years by the author, has shown that the answer to the species problem in *Succinea* will not be found in the study of the genitalia. Species with readily distinguishable shells have very similar genitalia. Thus, *Succinea pronophobus* Pilsbry, *S. wilsoni* Lea, and *S. urbana,* new species, are not separable by the genitalia. *Succinea campestris* Say, *S. luteola* Gould, and *S. floridana* Pilsbry, form another similar group. (The difference in the thickness of the penial sheath reported by Pilsbry does not exist in my material. Possibly the thickness may vary with the age of the animal.) The genitalia will be of value in the recognition of species groups, but shell characters will have to be used in many cases for species identification. On the other hand, in the genus *Catinella* very good specific differences are to be found in the anatomy, especially in the shape of the penis. In this genus this will probably prove to be a more reliable character than the shape of the shell.

SUCCINEA URBANA, new species. Pl. 4, figs. D & E; Text-fig. 1, A & C.

Shell pale golden-brown in color, subtranslucent, dull, with about 3.5 whorls, elongate-ovate, rather thin, sculpture of unevenly spaced growth wrinkles. Spire acute, long, sutures only moderately impressed; whorls moderately convex. Aperture ovate, rather small, occupying about 55% of the length of the shell, outer and basal margins well rounded. Columella nearly straight.

Color pattern variable, some with mantle grayish, others with a bold pattern of black and pale grayish-brown, margin of foot gray. Hermaphrodite duct moderately pigmented. Talon moderately pigmented, club-shaped, two lobed and with a median groove. Prostate gland large, almost square due to pressure from the other organs, moderately pigmented. Vas deferens not very long, entering the penis below the terminal loop, somewhat expanded below where it joins the penis. Penis moderately slender, with an inflated loop at the upper end. Penial retractor connected to the penis below the terminal loop, Atrium and vagina very short. Spermatheca large, globose, duct slender.

Length	Diam.	Apt. L.	Ap. W	
11.1 mm.	6.0 mm.	6.0 mm.	4.0 mm.	Holotype.
10.9 mm.	5.7 mm.	6.0 mm.	4.0 mm.	Paratype.
11.7 mm.	6.3 mm.	6.6 mm.	4.2 mm.	Paratype.

Type Locality. *Alabama:* Montgomery Co.: vacant lot, Dudley St., and Fairview Ave., Montgomery, holotype 205901 and para-

types 205902 U.M.M.Z., other paratypes 23392, collection of the author.

Succinea urbana appears to be most closely related to *S. wilsoni* Lea, which it resembles in its genitalia. It differs in its thicker shell with smaller aperture and more obese spire.

(To be concluded)

PUERTO RICAN PUPILLIDS AND CLAUSILIOIDS

By H. BURRINGTON BAKER

The symbols used for Puerto Rican localities were explained recently (1961).[1] Very few of the smallest species, especially the leaf arboreal ones, which may mature in a few months, were obtained, probably because these may be much reduced in numbers or represented only by eggs and/or young during the dry periods, because cultivated areas were avoided, and since no humus was sifted or saved. All the pupillids are distributed widely, probably by human agencies.

Pupoides (s.s.) nitidulus (Pfeiffer). Enl; lowland species, mapped by van der Schalie, 1948:38, from Ps, Wn & Ws, and reported by Dall & Simpson, 1901:372, from Fajardo (Ee).

Gastrocopta (s.s.) pellucida (Pfeiffer). Lowlands, Es2, Ps2.

G. (s.s.) servilis (Gould). Lowlands, Es2, Ps2, Ws.

Pupisoma (Ptychopatula) dioscoricola (C. B. Adams). Pnl (young). Two other leaf arboreal Nesopupinae, *Bothriopupa tenuidens* (C. B. Adams) and *P. minus* Pilsbry, reported by van der Schalie, 1948:36, 39.

Vertigo (s.s.) ovata Say, subspecies? So reported by Pilsbry, 1919 (3a):87, pl. 13, fig. 16, from Humacao (Es); since he also stated "there is nothing to differentiate it," why not drop *Pupa hexodon* Adams, from Jamaica, as obsolete?

Cerion (Strophiops) striatella (Guérin) + *C. crassilabris* (Sowerby); see Pilsbry, 1943 (5):34, but *striatella* retains its original ending. Ps1, under bunch grass; Ps2, roosting on tree trunks; apparently limited to southwest limestone rim. Shells from 19.0 mm. long with 8¼ whorls (Ps2) to 31.1 with 11 (Ps1), so *C. monaense* Clench, 1951:274, not always smaller, but does have stronger and more widely spaced costae than in any P. R. shells seen. Color varying from whitish, through those with brown flammules, to almost uniformly brownish.

Pallial complex of *C. striatella* (Ps2) and of *C. uva* (L) from just south of Willemstad, Curacao, fundamentally similar to that of *C. incanum* [Pilsbry, 1946 (11):160, fig. 76, G] but much more

[1] In the remarks about *Cepolis boriquenae*, p. 147, change Ps4 to Es4 (Humacao).

elongate (less contracted?) ; lung wall 5 times as long as kidney or 7 times its apical width; sometimes with vague, whitish strip along hindgut (Cf. *Nenia*) especially towards pneumostome; kidney about 1¼ length of pericardium, with broad base (much as in *Nenia*), without ureter but with similar subapical opening. Mantle collar with weak lappets (similar to those in *Nenia*).

Genitalia of *C. striatella* very similar to those of *C. incanum* (Pilsbry, figs. H to K); only differences, most of which might be due to contraction and/or sexual stage, will be noted. Ovotestis of 4 lobes of alveoli, imbedded in 3rd whorl of liver. Carrefour also without definite talon. Spermatheca similar but without diverticulum in 5 examples dissected; stalk more swollen near base; in 2 animals, containing spermatophores, each of which is a fragile, thin walled, very slender, horny tube (about as long as spermatheca and its stalk) and with, for at least part of its length, 2 thickenings, that are separated by about ¼ its circumference. Vagina similarly receiving branches from right ocular retractor, which does not pass through penis-vaginal angle. Vas epiphallus evidently involving most of free loop and thus about equalling spermatophore in length; beginning as gradual enlargement of vas lumen near penis-vaginal angle; mainly with thin wall which internally has irregularly transverse, lobulate thickenings; attaining its maximum diameter in descending limb; tapering and with wall becoming much thicker and more muscular (at expense of lumen) towards entrance into penis near base of last. Penis and largely atrial "stimulator" very similar; penial retractor arising low on diaphragm and inserting on apex and down along one side for about ½ length of caecum.

Genitalia of *C. uva* (pl. 3, figs. 3, 4) and *C. uva bonairensis* also similar to preceding, but with salient differences as noted. Spermatheca (S) extending to about ⅔ length of spermoviduct; diverticulum (SD) present in those examined, recurved apically but not extending above aorta; common stalk (SS) longer and more slender but no spermatophores seen (resting?), about 1⅓ length of free oviduct (UV). Long vas epiphallus (E) swollen (but with smaller lumen) near opening (EP) at bifurcation of large penial pilaster. Penis (P) relatively longer, with only ⅓ its length above vas entrance. Penial apex internally (fig. 3) with heavy longitudinal folds but basal 2/5 with smooth wall except for pilaster and strictly penial "stimulator" (PP) which is similar in outline but is simply a discontinuous, elliptic thickening (i.e., without free tip). Atrium relatively shorter.

The differences in at least the penis of *C. uva* may represent subgeneric characteristics of *Cerion s.s.*, of which it is the only species. On the other hand, the presence or absence of a spermathecal diverticulum may be of little significance; Pilsbry stated

it was variable in *C. incanum* and it evidently is a vestige of the long, more primitive kind of geophile spermatheca, in which the sac is imbedded above the aorta. Also, the swelling (Pilsbry: fig. I, epi) of the long vas epiphallus near its entrance into the penis apparently is caused by the contraction of this region with more muscular wall but smaller lumen.

Nenia (s.s.) tridens (Schweigger). Usually roosting on tree trunks or vines up to 8 ft., but rarely on fallen leaves or on rocks; Er-1, 2, 3, Es3, Jn1, 100 to 2400 ft., eastern Puerto Rico. Foot quite short but broad; sole with 2 or 3 coarse waves on middle zone; animal moves along some distance and then jerks shell up after it. Embryonic whorls of shell about 2½, teat-shaped, relatively smooth and without major costulae but assuming at about ¼ whorl close, microscopic, growth wrinkles, which become fine, punctulate threadlets by end; 2nd whorl much higher than first; later whorls assuming major costulae and crenulate suture very quickly; young shells without apertural teeth.

Pallial complex (pl. 3, fig. 1) fundamentally similar to that of *Cerion;* lung wall about 5 times as long as its apical width or 3 times length of kidney; similarly without much secondary venation, although minute, pigmented tributaries are visible along sides of principal vein (HV); kidney (K) about twice as long as its base or length of pericardium (H), with similarly subapical, external opening (KX) and without ureter. [Although, in some examples, discontinuous, whitish zones (mucus or thickening?) are visible along hindgut (HG) and kidney, these certainly are nothing like the definite thickening along the hindgut in those sigmurethrous geophiles (e.g., Oleacinidae) in which the external ureteric opening is in the apical corner of the lung. Possibly these vague zones were why Wiegmann, 1893:226, described *Phaedusa* as sigmurethrous; this apparently was copied by Thiele in his "Handbuch."] Mantle collar (MC) with moderate parietal (left) and small, separate palatal (right) lappets.

Genitalia as represented by P. Hesse, 1925; only additions and differences will be noted. Ovotestis (not unlike that of *Clausilia* s. s.; Cf. Steenberg, 1914) consisting of 3-4 conical groups of simple and bifurcate alveoli; hermaphroditic duct much swollen and convoluted for ½ its length. Carrefour (Steenberg:pf) with very short talon (Steenberg:vs). Sac of spermatheca extending almost to tip of diverticulum, which reaches to near apical end of spermoviduct; spermathecal stalk relatively longer than in Hesse's fig. (apparent differences may be due to preservation and/or sexual stage). Penis (P. fig. 2) thin walled, with several internal pilasters, passing gradually (EP) into vas "epiphallus" (Steenberg: canal déférent) which has thick, muscular walls and small lumen (Cf. Steenberg: fig. 20) and looks more like an ejaculatory organ

than an epiphallus; penial retractor (PR) arising low on diafram and inserting little below middle of "epiphallus" (DE to EP); base of penis and terminal end of vas proper (up to DE) bound by thin sheath. Left ocular retractor in penis-vaginal angle (as stated by Hesse).

Undoubtedly, the Clausiliidae (at least *Nenia*)[2] and the Ceriidae (Cerionidae Pilsbry) are closely "related;" although the traditional family distinction should be retained, they belong in the same superfamily; its name (-oidea or -acea) would come from the oldest family, Clausiliidae Moerch, 1864. Both belong in the Mesurethra (1955) near the pupilloids (Orthurethra), in which the pallial complex mainly differs by the proximity of the external renal opening to the pneumostome; even in this respect, the Partulidae somewhat approach the Mesurethra.

Incidentally Thiele in his "Handbuch" retained this position for the Clausiliidae and it approximates the traditional location of the Ceriidae as well; *Cerion uva* (L.) is the type species of *Pupa* Lamarck, in which genus most of the older pupillid species were described, and the obsolete Pupidae Fleming, 1818, is the oldest name for the family. In this case, the resemblances in shell forms perhaps are not secondary convergences. As Pilsbry, 1904 (0):176, suggested, the Megaspiridae probably also belong near the Clausiliidae (and the Ceriidae).

Added references (See 1961)

1955, Naut. *68*:109. 1961, Naut. *74*: 142-149.
Clench, William J. 1951, J. de Conch. *90*:269-276 & pl.
Hesse, P. 1925, Proc. Malac. Soc. London *16*:154-155.
Steenberg, C. M. 1914, Mindeskrift, f. J. Steenstrup, no. 29:46 pp. & pl.
Wiegmann, F. 1893, Zool. Erg. Niederl. Ost-Indien 2:226.

JEANNE SANDERSON SCHWENGEL, Sc.D.
1889 to 1961

Dr. Schwengel was born Jeanne Sanderson, in Stockton, California, July 12, 1889. She attended public schools at her birthplace, and also St. Xavier's Academy, Chicago, Illinois. To help

[2] Since the above was written, through the generosity of Dr. F. E. Loosjes, of Wageningen-Hoog, The Netherlands, animals of *Clausilia bidentata* (Stroem) and *Lacinaria plicata* (Draparnaud) have been examined. In both of these species, the pallial complex is quite similar to that of *Nenia*.

her with her conchological studies, she also studied biology and Latin at Fordham University, New York City. On January 24, 1918, she was married to Frank R. Schwengel, who subsequently retired from the U. S. Army as Brigadier General, and became Chairman of Joseph E. Seagram and Sons, Inc. On February 17, 1961, while attending the annual meeting of the St. Petersburg Shell Club, at which she was scheduled to deliver an address, her over-willing heart failed her. She died suddenly, after her return to the hotel, where she was staying temporarily. She is buried in Scarsdale, where she resided for many years. Her husband survives her.

She did many of her studies on mollusks at the Academy of Natural Sciences of Philadelphia, where she worked with Dr. Pilsbry, and was appointed Research Associate in 1935. In 1943, the University of Dayton conferred on her the honorary degree of Doctor of Science, in recognition of her contributions to the science of conchology. In 1950, the Board of Overseers of Harvard College appointed her a member of the visiting committee of the Museum of Comparative Zoology.

In addition to her laboratory studies, she was an indefatiguable collector in the field, and helped in much dredging, especially off the coasts of Florida. She assisted Dr. Louise M. Perry in the compilation of molluscan records for the latter's "Marine shells of southwest Florida," 1940, helped revise it, and became co-author of "Marine shells of the western coast of Florida."

Dr. Schwengel was elected Vice-President of the American Malacological Union in 1950; became its President in 1951; graciously presided over the eighteenth annual meeting at Boston in August, 1952; and helped its progress as a member of the council for the rest of her life. As many of the members will remember, she gave delightful evening parties at many of the meetings, before and after.

She was a member of the following scientific associations: Academy of Natural Sciences of Philadelphia (since 1935), American Malacological Union (1936), American Association for the Advancement of Science (1940), Malacological Society of London (1947), Paleontological Research Institute, Ithaca, N. Y. (1953), Natural Science Foundation, Philadelphia, Pa. (Director from 1955 to 1958), Philadelphia Shell Club (1955), and Hawaiian

Malacological Society (1955).

She also shared in many other activities. She was a member of the American Red Cross in Houston, Texas (1918), in Chicago, Illinois (1920-1932) and in Scarsdale, N. Y. (1935-1945); and was Chairman of Production from 1943 to 1953. Since 1943, she also belonged to the Scarsdale Woman's Club and was Chairman of the Garden Section from 1954 to 1956.

Jeanne, as she was known to her many friends, will be long remembered for her ready smile and happy presence. The name of Dr. Schwengel will be carried on by her publications about conchology and by her large shell collection, from which she gave many lots to various institutions, and left the main part to the Museum of Comparative Zoology at Harvard College. — Editors.

Contributions to conchology

1938 (1) May 13. Zoological results of the George Vanderbilt South Pacific Expedition, 1937. Part I, — Galapagos Mollusca. Proc. Acad. Nat. Sci. Philadelphia *90*:1-3, 3 figs. *[Daphnella thalia, Marginella rosa, Tralia vanderbilti].*

1938 (2) July 22. Note on unreported marine molluscs from Sanibel, Florida. By Louise M. Perry, J. S. S. & Ted Dranga. Naut. *52* (1) :27-28.

1940 (0) Jan. 28. *[Cerithium auricoma, Latirus cymatius;.* See 1940 (0)]. Naut. *53* (3) :pl. 12, figs. 6-8a.

1940 (1) April 29. Two new Floridan marine shells. Naut. *53* (4) :109-110. [See 1940 (0).]

1940 (2) Nov. 2. New Mollosca from Florida. Naut. *54* (2):49-52, pl. 3, figs. 3, 3a, 6-9, 12. *[Marginella jaspidea, Crassispira phasma, Fenimorea halidorema, Glyphostoma pilsbryi, Bellaspira (?) pentapleura.]*

1941 (1) Oct. 24. A genus and family of marine mollusks new to the United States. Naut. *55* (2) :37-40, pl. 3, figs. 1-5. *[Lobiger pilsbryi.]*

1941 (2) Oct. 24. *Marginella hartleyana.* Naut. *55* (2) :65, pl. 3, figs. 6, 7.

1942 (1) May 7. Living *Mitra florida.* Naut. *55* (4) :144.

1942 (2) July 23. Some new and interesting marine shells from northwest Florida. By J. S. S. & Thomas L. McGinty. Naut. *56* (1) :13-18, pl. 3, figs. 2, 3, 5; pl. 4, f. d. *[Calliostoma (Eutrochus) faustum, C. fascinans, Douglassia bealiana, Trivia maltbiana, Aclis hypergonia, Cyclostrema (Aorotrema) pontogenes* (n. subg.)]

1942 (2a) July 23. *[Pteria xanthia, Phos adelus, Tritiaria virginiae, Lamellaria leucosphaera.]* Naut. *56* (1) :pl. 3, figs. 1, 1a, 4, 6-9. See 1942 (3).

JEANNE SANDERSON SCHWENGEL

1942 (3) Oct. 14. New Floridan marine mollusks. Naut. *56* (2) : 62-66, pl. 6, figs. 1-3. *[Terebra glossema;* see also 1942 (2a).]
1943 (1) Feb. 15. New marine shells from Florida. Naut. *56* (3) : 75-78, pl. 7, figs. 1-7. *[Marginella denticulata destina, M. idiochila, Eubela mcgintyi, Drupa didyma, Epitonium (Cirsostrema) linteatum.]*
1943 (2) July 23. *Diadora jaumei.* Naut. *57* (1) :32.
1944 (1) Feb. 9. *Smaragdia viridis viridemaris.* Naut. *57* (3) :106.
1944 (2) Aug. 17. A new *Modiolaria* from Florida. By R. A. McLean and J. S. S. Naut. *58* (1) :16-17, pl. 1, fig. 10. *[Modiolaria skomma.]*
1944 (3) Aug. 17. A new Floridian *Lamellaria.* Naut. *58* (1):17-18, pl. 1, figs. 3-6, 6a. *[Lamellaria koto.]*
1949 (1) Mar. 18. A new Japanese limpet. Naut. *62* (1) :97-98, pl. 6, figs. 1-1c. *[Acmaea langfordi.]*
1949 (2) Mar. 18. *Fusinus spectrum,* a new record for the Gulf of Mexico. Naut. *62* (1):101-102.
1949 (3) Nov. 1. *Liguus* enlarges its menu. Naut. *63* (2) :72.
1950 (1) Feb. 13. Two Pacific species of *Phos.* Naut. *63* (3) :80-82, pl. 5, figs. 3, 4. *[Phos lannumi, P. amoenus.]*
1951 (1) Mar. 7. New marine mollusks from British West Indies and Florida keys. Naut. *64* (4) :116-119, pl. 8, figs. 1-8. *[Crassispira drangai, Oliva drangai, Pitaria cordata, Calliostoma jujubinum adelae.]*
1955 (1) Marine shells of the western coast of Florida. By Louise M. Perry and J. S. S. Paleont. Research Inst., 198 pp., 55 pls.
1955 (2) Aug. 1. New *Conus* from Costa Rica. Naut. *69* (1) :13-15, pl. 2, figs. 1-15. *[Conus drangai, C. andrangae, C. gradatus thaanumi, C. recurvus helenae.]*
1957 (1) April 29. Theodore Thomas Dranga, 1901-1956. Naut. *70* (4) :138-140.
1958 (1) Mar. 4. Dr. H. A. Pilsbry in marine malacology. Naut. *71* (3) :87-89.

NOTES AND NEWS

Dates of the Nautilus. — Vol. 74, no. 1, pp. 1-40, pls. 1-4, was mailed July 1, 1960. No. 2, pp. 41-84, Oct. 5, 1960. No. 3, pp. 85-124, pls. 5-8, Jan 11, 1961. No. 4, pp. 125-166, pls. 9 & 10, April 6, 1961. — H. B. B.

First European Malacological Congress. — Under the auspices of a committee appointed by the Conchological Society of Great Britain and the Malacological Society of London, scientific and field meetings are planned in London, September 17 to 21, 1962. All aspects of European malacology and the formation

of a European Malacological Union will be discussed. However, the Congress will be open to all interested in malacology from any part of the world. Inquiries should be addressed to the Honorable Secretary:

Rev. H. E. J. Briggs, 19 Siward Road, Bromley, Kent, England.

Directory of conchologists, 1962. — I wish to include all persons and institutions interested in the study or collection of mollusks in this new directory, which will be published next January. A copy need not be purchased, but those who remit $2.50 now will receive the first copies printed. When known, the names will be followed by numbers, indicating interests from following key (or other special interests will be listed when mentioned): 1, world wide shells. 2, land shells. 3, fresh water shells. 4, fossil shells. 5, exchange shells. Secretaries of shell clubs or institutions will please send me a list of their members and their specialties. —John Q. Burch, 4206 Halldale Ave., Los Angeles 62, California.

On the delayed description of *Xylophaga atlantica*.—The wood-boring clam *Xylophaga atlantica* was described as a new species by Richards in 1942 (Nautilus *56*:58). Turner subsequently remarked in her monograph on the Pholadidae that, "It is surprising that this western Atlantic species remained undescribed until 1942" (Johnsonia *3*:153. 1955).

Recently the writer discovered a letter in the file of E. S. Morse papers deposited at the Peabody Museum of Salem which indicates that this bivalve was recognized as a new species at a much earlier date. Following is the letter, published here with the permission of its writer, Dr. Henry Jackson, Jr., and the Director of the Peabody Museum, Ernest S. Dodge:

"My dear Mr. Morse,

I suppose you are very busy, but could you lend me the drawings you made of the *Xylophaga* I found at North Haven. It is, without much doubt, a new sp. This I will be able to ascertain very soon as Mr. Henshaw has sent to England for all the species of the genus. When I describe it I shall like to have all the drawings I can of it. I have prepared a very excellent one of *Xylophaga dorsalis* Turton and also one of my [sic] species which with your permission I will name *Xylophaga* [of Morse]

nov. sp. I will be very careful of your drawings if you condescend to have them published by me in the *Proceedings of the Boston Society of Natural History.*"

The letter was undated, but in the judgment of Dr. Jackson, it was written in 1907 or 1908. In Dr. Turner's monograph (ibid-p.154), specimens of *X. atlantica* are listed from "off North Haven (Maine) in ten fathoms" which are deposited in the U.S. National Museum. These specimens were the ones collected by Dr. Jackson in 1907. He does not now recall why his study was never published. Possibly because of his age (about 15 years at that time), his paper was not accepted for publication, although he did publish two short papers in the Nautilus in 1907 and 1908. Or, it might have been that interest in the matter was lost while preparing for a trip to Europe that year. Possibly he was discouraged by Dr. Morse from publishing a description at that time. Thirty-four years later the situation was corrected by Dr. Richards.—Ralph W. Dexter, Kent State University, Kent, Ohio.

PUBLICATIONS RECEIVED

Pages in *italics* include new taxons.

1959

Adam, William. Les céphalopodes de la mer Rouge. Miss. R. P. Dollfus en Egypte. Rés. Sci. *3* (28) :125-193, pls. 1-9, 25 figs.

Basch, Paul F. Two new molluscan intermediate hosts for *Paragonimus kellicotti*. J. Parasit. *45*:273. Studies on the development and reproduction of the fresh-water limpet, *Ferrissia shimekii* (Pilsbry). Trans. Amer. Microsc. Soc. *78*:260-276.

Burch, John Bayard. Chromosomes of aquatic pulmonate snails (Basommatophora). Dissertation abstracts *20* (4) : 2 pp.

Emerson, William K. The gastropod genus *Pterorytis*. Amer. Mus. Novitat. no. 1974, *8 pp.*, 4 figs.

Ghose, Krishna Chandra. Observations on the mating and oviposition of two land pulmonates, *Achatina fulica* Bowdich and *Macrochlamys indica* Godwin-Austen. J. Bombay Nat. Hist. Soc. *56*:183-187.

Schalie, Henry van der & Dee S. Dundee. Transect distribution of eggs of *Pomatiopsis lapidaria* Say, an amphibious prosobranch snail. Trans. Microsc. Soc. *78*:409-420, 5 figs.

1960

Adam, William. Cephalopoda from the Gulf of Aqaba. Israel Sea Fish. Res. Sta., Bul. 26:*26 pp.*, pl. 1, 10 figs. Contribution

a la connaissance de l'hectocotyle chez les Ommastrephidae. Bul. Inst. roy. Sci. nat. Belgique *36* (19) :10 pp. A propos de *Chlamys* (F.Acc. *Hinnites) abscondita* (P. Fischer, 1898) de la cote occidentale de l'Afrique. Ibid. (20) :10 pp., 2 pls. Les mollusques terrestres et dulcicoles de la Belgique. Quelques additions et rectifications. Ibid. (22) :10 pp., 7 figs. Les céphalopodes de l'Institut Francais d'Afrique Noire, 2. Bul. ibid. *22*:465-511, 4 figs.

Barbosa, Frederico S., Elizabeth Carneiro, Ivete Barbosa & Jose F. Magalhães. Manual de malacologia médica (Trabalhos práticos) . Pp. 182, 110 figs. Fundacäo Goncalo Moniz, Salvador, Bahia, Brasil.

Branson, Bradley A. Gastropoda of the Rob and Bessie Welder Wildlife Foundation Refuge, San Patricio County, Texas. Southwest. Nat. *5*:143-159.

Burch, John B. Chromosomes of *Gyraulus circumstriatus,* a freshwater snail. Nature *186*:497-498, 1 fig.

Cooke, C. Montague, Jr. & Yoshio Kondo. Revision of Tornatellinidae and Achatinellidae (Gastropoda, Pulmonata). Bul. Bishop Mus. 221:*1-303,* 123 figs. ($6.50) .

Emerson, William K. Remarks on some eastern Pacific muricid gastropods. Amer. Mus. Novitat. no. 2009:15 pp., 7 figs.

Hubricht, Leslie. The cave snail, *Carychium stygium* Call. Trans. Ky. Acad. Sci. *21*:35-38, 2 figs.

Kuroda, Tokubei. A catalogue of molluscan fauna of the Okinawa Islands. Pp. 106, 3 pls.

Leonard, A. Byron & John C. Frye. Wisconsinan molluscan faunas of the Illinois valley region. Ill. State Geol. Surv., Circular 304: 32 pp., 4 pls., 3 figs.

Morton, J. E. Molluscs: an introduction to their form and functions. Harper Torchbooks, The Science Library; 232 pp., 23 figs. ($1.40).

Paraense, W. Lobato & Newton Deslandes. *"Drepanotrema surinamense,"* with an addendum on *"D. petricola"* (Planorbidae) . Rev. Brasil. Biol. *20*:257-263, 7 figs.

Schalie, Henry van der. Egypt's new high dam—asset or liability. Biologist *42*:63-70, 3 maps.

Scott, M. I. Hylton. Nueva familia de pulmonado Basomatoforo, Neotropico *6:65-69,* fig. 1. Sobre la presencia del genero *Pupisoma* en la Argentina. Ibid.:*25-29,* figs. 1-9.

Smith, Allyn G. A new species of *Megomphix* from California. Occ. Papers Calif. Acad. Sci. no. 28:*3 pp.,* 3 figs.

Soot-Ryen, T. Pelecypods from Tristan da Cunha. Results Norweg. Sci. Exp. to Tristan da Cunha, no. 49:*47 pp.* (3 pls.) , 9 figs.

Voss, Gilbert L. Bermudan cephalopods. Fieldiana, Zoology *39:419-446,* figs. 73-75.

THE NAUTILUS

Vol. 75 October, 1961 No. 2

TWO NEW STROBILOPIDS FROM THE PLEISTOCENE OF THE HIGH PLAINS

By TONG-YUN HO and A. B. LEONARD

In the summers of 1958 and 1959, studies on the Pleistocene geology and molluscan faunas of the White (Blanco) River area in northwestern Texas were carried out by us. In the course of these studies, numerous fossil shells of *Strobilops* of problematical taxonomic status were found associated with other pulmonate mollusks in fluviatile deposits ranging in age from Kansan to Wisconsinan. About 200 specimens of *Strobilops* have been obtained from the White River area. We were unable to assign these shells to any known species owing to their consistent characteristics intermediate between extinct *S. sparsicostata* F. C. Baker (1938:127) and living *S. texasiana* Pilsbry and Ferriss (Pilsbry, 1948:856). For these reasons and because of their wide geographic distribution and stratigraphic range, it seems best to propose a new name for these fossil shells. Series of several Pleistocene *Strobilops* from the post-Nebraskan of Central High Plains were restudied. Those series of *Strobilops,* which had been confused with *S. sparsicostata,* appear to belong to the new species described here.

STROBILOPS LONSDALEI, new species. Plate 6, figs. 1-2; text figs. 1-2

Diagnosis: Shell large for *Strobilops,* having trochiform outline; decidedly angulate last whorl; 5½ to 6 convex whorls sculptured by 40 to 50 moderately spaced, moderately thickened, oblique ribs passing over base without diminishing; weak and nodose infraparietal lamella.

Holotype: Catalogue number 12180, University of Kansas Museum of Natural History, obtained by A. B. Leonard and Tong-yun Ho, June 9, 1959. Original number TYH 34.

Description of holotype: Shell large, trochiform; whorls 6 in number, moderately convex, slowly increasing in size; last whorl decidedly angulate; base broadly rounded; first 1½ whorls finely granulose, remaining whorls covered by moderately spaced, moderately thickened ribs passing over base without reduction in size, except for those immediately in front of aperture; diameter

of umbilicus equivalent to 1/8 greater diameter of shell; aperture lunate, expanded, having moderately thick parietal callus and peristome; parietal lamella nodose, high, emerging to edge of parietal callus and penetrating about 3/4 of a whorl inward; interparietal lamella nodose, weak, shortly emerged and penetrating as deep as parietal lamella; infraparietal lamella nodose, weak, shortly emergent and penetrating as far as parietal lamella; columellar lamella weak; first basal fold moderate, triangular; second basal fold high, broadly triangular, nearly as long as first basal fold; third basal fold low, about 1/2 length of second basal fold; fourth and fifth basal folds low, each approximately twice length of third basal fold; palatal fold low, longer than fifth basal fold (internal anatomy from paratypical shell).

Paratypes: Many variations occur among more than 200 paratypes in the length, thickness, and number of baso-palatal folds, and in the development of ribs. The baso-palatal folds in most shells are 5 in number but in a few specimens a small fold is present between the third and fourth basal folds. The inter- and infra-parietal lamellae are extremely weak and may become discontinuous in some examples. The number of ribs ranges from 40 to 50. In some examples, a faint riblet is between major ribs. The ribs on the base may become weak on the last half of the base or near the umbilicus in some shells; as a rule they are conspicuous on last half of base.

Comparisons: S. lonsdalei is clearly distinguished from *S. sparsicostata* (Plate 6, figs. 5-6; text figs. 4-5) by having ribbed base, weak nodose infraparietal lamella, and fine and narrowly spaced oblique ribs, always more than forty in number. The denticles as a group are always weaker than are those of *S. sparsicostata.* The parietal lamellae are nodose in *lonsdalei,* but most of them are always smooth in *sparsicostata.* The palatal fold is generally present in *lonsdalei,* but it is absent in some specimens of *sparsicostata.*

The shell of *S. lonsdalei* differs from that of *S. texasiana* (see Pilsbry, 1948, fig. 464:5-11) in being large and trochiform instead of small and dome-shaped. The last whorl is subangulate or rounded in *texasiana,* whereas it is decidedly angulate in *lonsdalei.* The ribs, which are always more than 50 in number in *texasiana,* are always less than 50 in *lonsdalei.* The ribs are also more widely spaced and coarser in *lonsdalei* than in *texasiana.* The internal structure of the shell of *lonsdalei* is also different

from that of *texasiana*. The latter has a tongue-shaped (blunt-topped) first basal fold, and high, rather flat-topped second basal fold, while in the former both the first and second basal folds are triangular in shape with subacuate tips. Unlike *texasiana, lonsdalei* has a low second basal fold and intraparietal lamella.

The comparisons of dimensions in millimeters and numbers of whorls are summarized in the following table. In the table, specimen H1 is the holotype, and specimens P1 and P3 are paratypes.

Species	S. sparsicostata				S. lonsdalei				S. texasiana			
Specimen	1	2	3	4	H1	P1	P2	P3	1	2	3	4
Diameter	2.7	2.7	2.6	2.5	2.8	2.8	2.7	2.7	2.4	2.3	2.2	2.0
Height	1.9	2.0	2.1	1.9	2.4	2.5	2.3	2.1	1.9	1.9	1.6	1.6
No. of ribs	34	36	36	34	41	44	48	45	52	50	52	51
No. of whorls	5.5	5.5	5.5	5.5	6	6	5.9	5.9	5.5	5.5	5.3	5.5

Type locality: Kansan terrace deposits in left bank of White River, near bridge on Texas Highway 261, 6.5 miles east of Kalgary, Crosby County, Texas.

Areal and stratigraphic distributions: At present *S. lonsdalei* is known from the Pleistocene deposits of Kansan to Wisconsinan age at 13 localities distributed from western Oklahoma to northern Texas. Representative localities, age of deposits, and approximate number of specimens obtained at each locality are as follows:

Kansan deposits, NW ¼, sec. 23, T. 23N., R. 18W., 2.5 miles west and ¾ mile north of Quinlan, Woodward County, Oklahoma. No. 4337, KU, 70 specimens.

Kansan deposits in road cut on Texas Highway 70, 1 mile north-northeast of Turkey, Hall County, Texas. No. 11848, KU, 10 specimens.

Kansan deposits in left bank of White River, near bridge on Texas Highway 261, 6.5 miles east of Kalgary, Crosby County, Texas. No. 11650, KU, 60 specimens. (Type locality.)

Kansan deposits exposed in cut bank, 2.2 miles west of Post, Garza County, Texas. No. 10854, KU, 40 specimens.

Wisconsinan terrace deposits on north side of U.S. Highway 83, 4.1 miles east of Crosbyton, Crosby County, Texas. No. 10237, KU, 150 specimens.

Wisconsinan terrace deposits, 5 miles northeast of bridge on

U.S. Highway 77 over Red River, northern central Cook County, Texas. No. 12123, KU, 10 specimens.

STROBILOPS LONSDALEI CANSASIANA, new subspecies. Plate 6, figs. 3-4; text fig. 3.

Diagnosis: Shell broadly conic, moderately elevated; whorls 5½ in number sculptured by 43 to 52 moderately spaced ribs; base almost smooth or finely striate; parietal lamellae penetrating from ½ to ⅝ of last whorl.

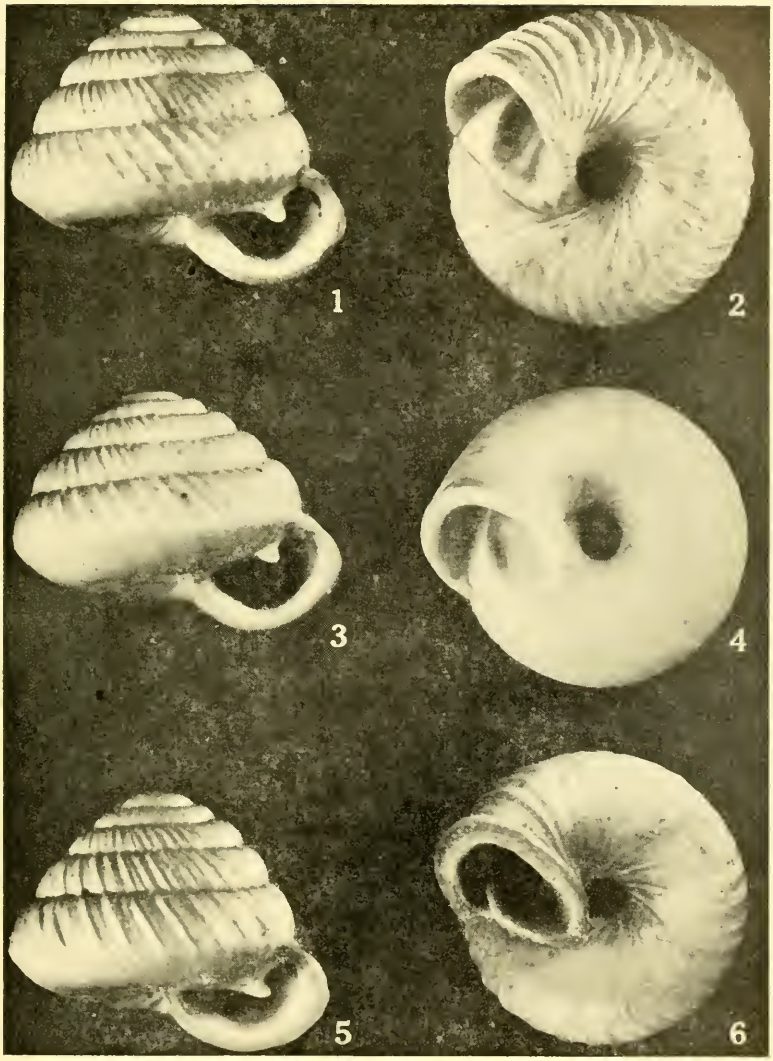
Holotype: Catalogue number 12181, KU, obtained by Dr. C. W. Hibbard, August 9, 1943.

Description of Holotype: Shell moderate, broadly convex; whorls 5½ in number, convex; last whorl decidedly angulate; base more or less narrowly rounded; first 1½ whorls finely granulose, remaining whorls sculptured by moderately spaced, moderately thickened ribs passing over base in extremely fine striae; diameter of umbilicus contained about 8 times in diameter of shell; aperture lunate, expanded, having moderate peristome and parietal callus; parietal lamella nodose, penetrating one-half a whorl inward; interparietal lamella nodose, weak, shortly emerged and penetrating as deep as parietal lamella; infraparietal lamella shortly emerged, longer than interparietal lamella, penetrating as far as parietal lamella; baso-palatal folds similar to those of *S. lonsdalei lonsdalei* (internal structure of shell based on paratype).

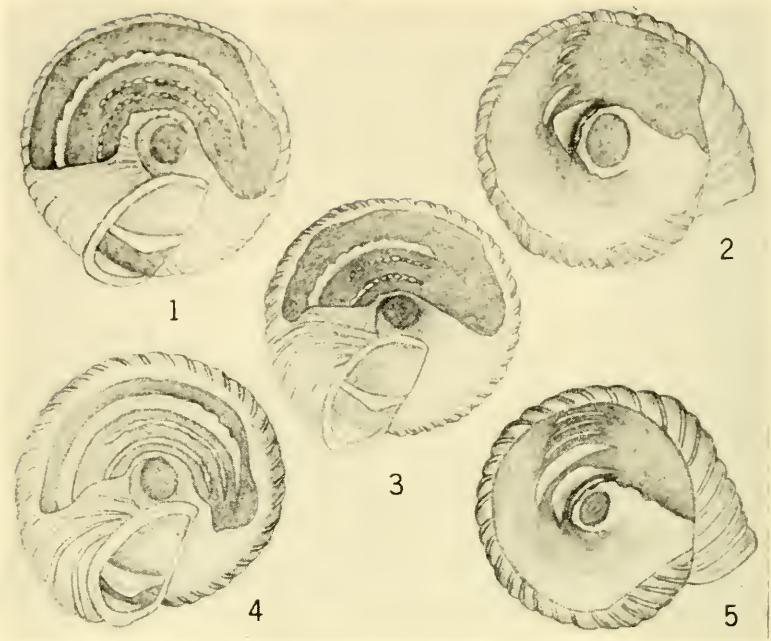
Paratypes: Few variations are noted in more than 2000 paratypes from 8 localities. The parietal lamellae pentrating ½ last whorl inward in most specimens, but about ⅝ last whorl in the specimens from Reno County, Kansas, and Greer County, Oklahoma. The base is smooth or finely striate in most examples, but a few ribs are present immediately behind the peristome of a few specimens. The baso-parietal folds are as variable as those of *S. lonsdalei lonsdalei.* Variations in size of shell, and number of ribs are exemplified in the following measurements:

	Holotype	Paratypes		
Diameter (mm.)	3.1	2.6	2.7	3.1
Height (mm.)	2.2	2.1	2.0	2.1
No. of ribs	45	52	44	43
No. of whorls	5.5	5.5	5.5	5.5

Comparisons: This subspecies differs from *Strobilops lonsdalei lonsdalei* in having smaller shell with broad and smooth base, less elevated spire, more ribs, and shorter parietal lamellae. All other characteristics appear to be similar to *S. lonsdalei lonsdalei. S. lonsdalei cansasiana* resembles *Strobilops texasiana* in having the same number of ribs, but the former differs from the latter



Figs. 1, 2. *Strobilops lonsdalei lonsdalei* Ho and Leonard. Lateral and basal views of holotypical shell. Figs. 3, 4. *S. lonsdalei cansasiana* Ho and Leonard. Lateral and basal views of holotypical shell. Figs. 5, 6. *S. sparsicostata* Baker. Lateral and basal views of topotypical shell from Rexroad Ranch, 9 miles south and 7 miles west of Meade, Meade County, Kansas. All figures enlarged approximately 15 times.



Sections of last whorl of *Strobilops* showing internal lamellae and folds of the shell. All figures enlarged approximately 14 times. Figs. 1, 2. *Strobilops lonsdalei lonsdalei* Ho and Leonard, paratypes. Fig. 3. *S. lonsdalei cansasiana* Ho and Leonard, paratype. Figs. 4, 5. *S. sparsicostata* Baker, topotypes.

in bearing rather coarse and widely spaced ribs, smooth base, and a decidedly angulate last whorl.

Type locality: Kansan deposits, SW 1/4, sec. 2, T. 31S, R. 28W., 6 miles north of Meade, Meade County, Kansas.

Areal and stratigraphic distributions: S. lonsdalei cansasiana is now known only from Kansan deposits in Iowa, Kansas and Oklahoma. The southern range of *S. lonsdalei cansasiana* overlaps with the northern range of *S. lonsdalei lonsdalei* in western Oklahoma. Representative localities and approximate number of specimens in our collections are:

Kansan deposits, 1 mile east and 4 miles north of Little Sioux, Harrison County, Iowa. No. 4517, KU, 11 specimens.

Kansan deposits, SW 1/4, sec. 2, T. 31S., R. 28W., 6 miles north of Meade, Meade County, Kansas. No. 3702, KU, 500 specimens. (Type locality.)

Kansan deposits, SW 1/4, sec. 26, T. 14S., R. 2E., 4 miles west of Navarre, Dickenson County, Kansas. No. 4501, KU, 10 specimens.

Kansan deposits, sec. 36, T. 24S., R. 7W., 7 miles east and 1.1 miles north of Arlington, Reno County, Kansas. No. 9414, KU, 15 specimens.

Kansan deposits, sec. 8, T. 5N., R. 28E, near north border of Gate, Beaver County, Oklahoma. No. 4743, KU, 150 specimens.

Kansan deposits in right bank of North Fork of Red River, north of Rock Island Railroad, 2 miles east of Granite, Greer County, Oklahoma. No. 10751, KU, 70 specimens.

Ecology and relationships: The ecological requirements of this extinct species are not certainly known. The association of it with *Retinella electrina, Pupilla muscorum, Stenotrema leai,* and its occurrence in the alluvium of fine and well-sorted sands and silts seems to imply that the species thrived in rather humid and cool situations on the flood plains where vegetation was available. The exact cause of extinction is unknown, but the initiation of semiarid and otherwise severe climate in the High Plains at the time of the Bradyan interglacial interval may have been responsible. This view is strengthened by the fact that no single species of *Strobilops* and no other northern gastropod that lived in the area during pre-Wisconsinan time, is found alive in the White River region today.

S. lonsdalei is morphologically and stratigraphically intermediate between *S. sparsicostata* of the Nebraskan and existing *S. texasiana,* which extends to the Wisconsinan, but is more closely allied to *S. sparsicostata* than to *S. texasiana* on the basis of size and shape of shell. In the light of our present knowledge, *S. lonsdalei* seems to be on a side branch of the line leading from *S. sparsicostata* to *S. texasiana. S. sparsicostata* may have given rise to *S. lonsdalei* by development of ribs on the base of the shell, by increase in the number of ribs, and by reduction in size of denticles.

S. lonsdalei is named in honor of the late Dr. John T. Lonsdale, formerly Director, The University of Texas Bureau of Economic Geology, in recognition of his continued interest and support of our studies in Texas.

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THE STATUS OF THYASIRA INSIGNIS, T. PLANA. AND T. INAEQUALIS, ALL VERRILL AND BUSH

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While working up the marine lamellibranchs of East Greenland (Ockelmann, 1959) a list was compiled of all the species known from the Atlantic sector of the Arctic and adjacent regions and, in many cases, I had to consult the original descriptions. It thereby appeared that the validity of some of the species of *Thyasira,* described by Verill & Bush (1898) from the east coast of North America, was rather doubtful and that they probably were synonymous with certain earlier described species. In particular, this seemed to apply to *Thyasira insignis, T. plana,* and *T. inaequalis.*

During a stay in the United States in 1959, I therefore took the opportunity to examine a major part of the collection of *Thyasira* kept in the U.S. Nat. Museum. This material includes the types as well as most of the specimens of *Thyasira* identified by Verrill & Bush. To facilitate a later thorough revision of the whole group, which is highly needed in spite of the useful papers by Dall (1901), and Lamy (1920), the results of my examination will be given here.

Thyasira insignis: This form was described as *Cryptodon insignis* by Verrill & Bush (1898, p. 785, pl. 91, figs. 1, 2). Two specimens were figured and, apparently, the authors did not designate a holotype. However, one of these specimens is now in the type collection of the U.S. Nat. Museum, probably selected by Dall when he prepared his 'Synopsis of the Lucinacea and of the American species' (1901). It is an empty shell (U.S.N.M. 52596) with the left valve drilled. This is depicted on fig. 2 in the paper by Verrill & Bush, while fig. 1, same plate, is drawn from a single left, drilled valve (U.S.N.M. 52733). Both specimens are from U.S.F.C. station 2499, N.44°46′30″ W.59°55′45″, depth 130 fath. ('Albatross', 1885). Further, 28 valves (U.S.N.M. 52557 and 52733) from stations of the U.S.F.C. 2498 and 2499, were present. Of the whole material, consisting of 1 shell and 29 valves, 11 still had remains of the ligament, but no trace of the soft parts whatever. Thus, they may very well have rested in the bottom deposits for a considerable time after death. A single

valve from off Cape Cod which at first was identified as *Cryptodon sarsii* by Verrill (1880, p. 399), but later (Verrill & Bush, 1898) referred to *C. insignis*, seems not to be present in the material. According to the latest lists of the marine mollusks of the east coast of North America, *T. insignis* occurs from Newfoundland to Cape Cod, Mass., 65-471 fms. (Johnson, 1934; La Rocque, 1953). This distribution, however, is simply based on the data of Verrill & Bush (1898) whose material solely consists of empty shells and valves. From this, apparently *T. insignis* has never been taken alive.

My examination of the type as well as the other material strongly suggests that *T. insignis* is not specifically distinct from *T. sarsi* (Philippi) 1845, b, p.91, as *Axinus sarsii*). The outline of the shell, its proportions, the appearance of its surface, the hinge margin, the size and the position of the ligament, as well as the scars and marks on the inner side do not differ in the two forms. The only observable differences are that, in some of the valves, the lower, posterior undulation from the umbo to the posterior-basal margin ends a little more ventrally than in most of the specimens of T. *sarsi*, and that T. *insignis* may become 32 mm. long, while the largest specimens of *T. sarsi* (valves from W. Norway) seen by me have a length of 23.5 mm. However, *T. sarsi* varies rather much in shape, as do several other species of *Thyasira*, and it also seems to attain fairly different maximum sizes in different localities. G. O. Sars, who gives good figures of the typical form (1878, pl. 19, fig. 5 a-b), shortly describes a 'monstr. *oblonga*' collected along with typical specimens at Lofoten. This form especially is virtually indistinguishable from *T. insignis*.

According to my own studies, *T. sarsi* now occurs from the Sound (Denmark) through the Kattegat, along the Swedish west coast and the Norwegian coast northward to at least Lofoten, and it is also found in some fjords of northwest Iceland. G. O. Sars (1878), however, states that it occurs as far northward as Vadsö (E. Finmark), and this may be correct, although I have not seen animals from that region. It has even been recorded farther north and east by other authors. Lamy (1920, p. 297), for instance, mentions it from the Kara Sea. However, since specimens of *T. gouldi* (Philippi) often have been identified

and listed as *T. sarsi,* the northern limit of distribution is not known with certainty. *T. sarsi* has also been recorded from W. Greenland (Posselt & Jensen, 1898, p. 80, as *Axinus flexuosus* var. *sarsii).* The Zool. Museum, Copenhagen, however, only possesses a single, empty shell from W. Greenland, viz. from Godthaab. The ligament of this shell is fairly well preserved, but soft parts are completely absent and the shell surface does not look 'fresh'. There are thus three possibilities: 1) This specimen is a quaternary fossil, and *T. sarsi* is now extinct at W. Greenland, 2) The specimen is wrongly labelled, and not collected at W. Greenland at all, or 3) *T. sarsi* occurs, although sparsely, in west Greenland water. At present, none of these interpretations can be excluded.

From the preceding data, I conclude that *T. insignis* merely represents a large form of *T. sarsi,* and that the former should be regarded as a subspecies of the latter and referred to as *Thyasira sarsi insignis* (Verrill & Bush). Further, no proof exists that this is an extant member of the recent fauna of the east coast of N. America, since all the specimens referred to it may very well be Quaternary fossils, thus indicating a wider distribution of *T. sarsi* in former times, viz. from the Scandinavian coasts to the region around Newfoundland and New England. This supposition also agrees with the record of an empty, possibly fossil, shell of *T. sarsi* from W. Greenland, and with the existing isolated population of N.W. Iceland.

Thyasira plana: This was described, with good figures, as *Cryptodon planus* by Verrill & Bush (1898, p. 788-9, pl. LXXXVIII, figs. 3, 4). The type (U. S. N. M. 159893) is a specimen from U.S.F.C. sta. 254, Cape Cod Bay, 'Fishing ledge', Wood End Light N. 50°E. 7 miles, 21 fath. ('Speedwell', 1879). A close examination of it left no doubt that it is an about half-grown specimen if *Thyasira gouldi* (Philippi) (1845 a, p. 74-75). It has a well-rounded outline which is often exhibited by smaller specimens of *T. gouldi.* Its hinge-margin is comparatively strong and fairly well-rounded below the umbo, a feature also found in *T. gouldi.* Furthermore, Verrill & Bush's statement as to the absence of a distinct tubercle or tooth-like projection is not quite correct. There is, just as in *T. gouldi,* a rather stout, though small, tooth in the right hinge close to, and below, the umbo,

and—as also shown by Verrill & Bush, fig. 3—a distinct pit or groove in the left hinge corresponding to it. A highly distinctive character of *T. gouldi* is the large, conspicuous prodissoconch which most often measures 210-250 microns across. This feature is also present in the type of *T. plana,* the prodissoconch of which measures about 215 microns across. Finally, all the other material investigated and originally labelled as *Cryptodon planus* also turned out to belong to *T. gouldi,* mostly being smaller specimens of it. This material originates from the following localities: Casco Bay, 1873. Seal Cove, 8-10 fms., Y. M., 1872, Chelsea Beach, Mass., Dall. Friars Head, Maine, Henderson Coll. U.S.F.C. stations 72+73, 42B+43B+58B+60B+66B+67B, 134, 136, 140, 160, 165, 181, 191, 199, 210, 283+285, 296, and 340 (serial numbers U.S.N.M. 74281, 74283-74286, 74289, 108868, 159848, 159849, 159876-159884, and 445797). There is also one sample from Maine, collected by Stearns, but without a serial number. Living specimens, identified as *Cryptodon planus,* were found at depth from 15-19m. to 188 m. and at temperatures between about 4.0° and 9.4°C. (These data are based upon Smith, 1887, according to the station numbers of the samples). The distribution agrees with that given by Johnson (1934), and La Rocque (1953), viz. from Halifax, N.S., to Cape Cod, Mass., and, according to these authors, the range of *T. gouldi* along the east coast of N. America is from Greenland to Connecticut, 5-400 fath. Abbott (1954, p. 384), however, gives the range as "Labrador to North Carolina," but without any references or details. *T. plana* thus occurs well within the range of *T. gouldi,* regardless of the depth record of 400 fath. for *T. gouldi* which seems doubtful and may not apply to living specimens. Actually, *T. gouldi* is uncommon at depth exceeding 100 m. and even at depths of about 50 m. often only smaller specimens are found. These are usually more rotund than are the larger ones; and apparently such specimens led Verrill & Bush to describe *Cryptodon planus.*

Thyasira inaequalis: This was described as *Cryptodon (Axinulus) inequalis* by Verrill & Bush (1898, p. 791, pl. 90, figs. 1, 2). Dall (1901, p. 786) is correct in regarding it as a *Thyasira* s.s., not an *Axinulus.* The type (U.S.N.M. 159850) is an animal from U.S.F.C. sta. 98, 99, midway between Sandwich Point and

McNab's Island Light, Halifax Harbor, depths of 18 fms. (Speedwell, 1877). On a close inspection, it turned out to be nothing but an aberrant specimen of *T. gouldi,* aberrant in so far as the outline of the shell is concerned. Otherwise it shows all the features typical of *T. gouldi;* the prodissoconch, for instance, measures about 215 microns across. Also the other material investigated (U.S.F.C. stations 72+73, 293, 296, and 340 (U.S.N.M. 74287, 159847, 202836, and 202837) comprises only specimens of *T. gouldi,* but of a more normal outline and shape. This again points towards the true nature of the type: An individual variant of *T. gouldi.* Just as is the case with *T. plana, T. inaequalis* is sympatric with *T. gouldi,* as it occurs from Halifax, N.S., to Cape Cod, Mass., 14 to 49 fath. (Johnson, 1934; La Rocque, 1953).

It is concluded, then, that both *Thyasira plana* (Verrill & Bush), and *T. inaequalis* (Verrill & Bush) must be regarded as junior synonyms of *T. gouldi* (Philippi). The available data do not justify a claim for even their subspecific status.

Most figures of *T. gouldi* in the literature are on a small scale and do not show the distinctive features satisfactorily. For convenience, therefore, references to usable figures may be given here: G. O. Sars, 1878, pl. 19, fig. 6 a-b (as *Axinus gouldii),* and Ockelmann, 1959, pl. 2, figs. 4-5.

My cordial thanks are due to Dr. Harold A. Rehder for kindly placing the collections and facilities of the U.S. National Museum at my disposal.

A few living adult *T. sarsi* have been found by me since, in the Gotthab Fjord, W. Greenland, July, 1961.

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MARINE SHELLS OF WATER ISLAND, VIRGIN IS.

By J. A. WEBER

Water Island is located about 3/8 of a mile east of St. Thomas. It consists mainly of volcanic rocks which rise to a height of 294 feet at the highest point, leaving a very rough topography. The water surrounding the island varies from shallow to a depth of 50 to 85 feet in the channels. The bays, sand beaches, rock ledges and coral reefs furnish a great variety of ecological situations for mollusks. Collecting is very convenient, as the proprietor of the island, Mr. Walther H. Phillips, maintains tourist cottages, where wet clothes and specimens may be handled. The writer made two trips to the island, one in August, 1956, and the other in July, 1958, which included shallow-water collecting and some dredging. The species collected follow:

Gastropods.
Acmaea antillarum
A. cubensis
A. leucopleura
A. jamaicensis
A. pustulata
A. pustulata pulcherrima
Acteon punctostriata
Alaba incerta
Alabina adamsi
Alvania auberi
Anachis albella
A. catenata
A. nitens
A. obesa
A. subcostulata
Antillophos candei
Architectonica nobilis
Arene cruentata
A. miniata
A. riisei
Aspella elizabethae
A. paupercula
Astraea americana cubana
A. caelata
A. longispina
A. tuber
Atys caribaea
A. sharpi
Batillaria minima
Bittium cerithioides
B. varium
Bulla occidentalis
Bullata ovuliformis
Bursa thomae
Caecum cooperi

C. decussatum
C. regulare
C. floridanum
C. pulchellum
Calliostoma jujubinum
C. pulcher
C. zonamestum
C. sarcodum
Cantharus auritulus
Cassis flammea
C. madagascariensis
C. tuberosa
Cerithides costata
Cerithiopsis iota
C. flavum
C. fusiforme
C. greeni
C. rugulosum
Cerithium algicola
C. eburneum
C. literatum
C. muscarum
C. variabile
Cerodrillia thea
Charonia variegata
Columbraria lanceolata
Columbella mercatoria
C. ovulata
C. ovuloides
Conus spurius
C. jaspideus
C. mus
C. regius
C. cardinalis
C. dominicanus
Coralliophila abbreviata
C. bracteata
C. caribaea
Crassispira ebenia
C. nigrescens
C. ostrearum
Crepidula aculeata
C. maculosa
C. plana
Cylindrobulla beaui
Cymatium gemmatum
C. muricium
C. nicobarium
C. parthenopium
C. pileare
Cyphoma gibbosum
C. macgintyi
Cypraea cinerea
C. spurca acicularis
C. zebra
Cypraecassis testiculus
Cythara trilineata
Daphnella lymneiformis
Decipifus pulchellus
Diodora arcuata
D. cayenensis
D. dysoni
D. minuta
Drillia elatoir
Drupa nodulosus
Echininus nodulosus
Emarginula phrixodes
E. pumila
Engina turbinellus
Engoniophos unicinctus
Epitonium albidum
E. candianum
E. echinaticostum
E. lamellosum
E. occidentale
E. unifasciatum
Erato maugeriae
Euchelus guttarosea
Fasciolaria tulipa
Fenimorea fucata
F. phasma
Fissurella augusta
F. barbadensis
F. barbouri
F. nimbosa
F. fascicularis
F. nodosa
F. rosea
Fossarus orbignyi
Fusilatirus cayohuesonicus
Glyphoturris diminuta
Haliotinella patinaria

Haminoea antillarum
H. elegans
Hemitoma emarginata
H. octoradiata
Hipponix antiquatus
H. subrufus
Hyalina albolineata
H. avena
H. avencia
H. tenuilabra
H. parkeri
Ithycythara lanceolata
Jaspidella jaspidea
Kurziella quadrilineata
Latirus brevicaudatus
Leucozonia nassa
L. leucozonalis
Litiopa melanostoma
Littorina angulifera
L. meleagris
L. mespillum
L. ziczac
Livona pica
Lucapina aegis
L. philippiana
L. sowerbyi
L. suffusa
Lucapinella limatula
Mangelia biconica
M. fusca
M. melantica
M. quadrilineata
Marginella sulcata
Meioceras nitidum
Melampus coffeus
Melanella jamaicensis
Micromelo undata
Mitra albicostata
M. albocincta
M. barbadensis
M. cubana
M. floridana
M. hanleyi
M. hanleyi gemmata
M. moisei
M. nodulosa
M. straminea
Mitrella duclosiana
M. fusiformis
Modulus carchedonius
M. modulus
Monilispira albocincta
M. jayana
M. leucocyma
Morum oniscus
Murex cabritti
M. cailleti kugleri
M. micromeris
M. pomum
Muricopsis oxytatus
Nassarina glypta
Nassarius albus
N. vibex
Natica canrena
N. livida
Neodrillia jamaicensis
Nerita peloronta
N. tessellata
N. versicolor
Neritina virginea
Nitidella dichroa
N. idalina
N. laevigata
N. nitidula
N. ocellata
Nodilittorina tuberculata
Odostomia laevigata
Oliva reticularis
Olivella adelae
O. dealbata
O. nivea
O. perplexa
Opalia pumilo
Parviturbo weberi
Pedipes mirabilis
Persicula miniata
Petaloconchus erectus
Phalium cicatricosum
Phenacolepas hamillei
Pira monile
Pisania pusio
Planaxis lineatus

P. nucleus
Polinices lacteus
P. uberinus
Prunum virginianum
Psarostula monilifera
Puperita pupa
P. tristis
Pyramidella crenulata
P. dolabrata
Pyrunculus caelata
Pyrgocythara coxi
P. emeryi
Retusa caniculata
Rissoa gradata
Rissoina bryeria
R. cancellata
R. chesneli
R. decussata
Rhizorus acutus
Sigatica semisulcata
Sinum perspectivum
Siphonaria alternata
S. pectinata
Smaragdia viridis
Spartophos floridanus
Stigmaulax sulcata
Synaptocochlea picta
S. coccina
Tectarius muricatus
Tegula excavata
T. fasciata
T. hotessieriana
T. lividomaculata
T. substriata
T. viridula
Terebra dislocata
T. glossima
T. hastata
Thais deltoidea
T. haemastoma floridana
T. rustica
Tonna maculosa
Torinia infundibulum
T. cyclostoma
Trailia ovula
Tricola adamsi
T. bella
T. tessellata
Trigonostoma rugosum
Trimusculus carinata
Triphora decorata
T. mirabilis
T. nigrocincta
T. pulchella
Tritonalia intermedia
Trivia pediculus
T. quadripunctata
Truncatella caribaeensis
Turbo canaliculatus
T. castanea
Turbonilla curta
T. interrupta
Vasum muricatum
Vermicularia spirata
Xenophora conchyliophora

Pelecypods.

Abra aequalis
Aequipecten acanthodes
A. muscosus
A. gibbus
Americardia guppyi
A. medium
Anadara notabilis
Anadontia alba
Anomalocardia brasiliana
Antigona listeri
A. rugatina
Arca umbonata
A. zebra
Arcopagia fausta
Arcopsis adamsi
Asaphis deflorata
Barbatia cancellaria
B. candida
B. domingensis
B. tenera
Basterotia newtoniana
B. quadrata
Botula fusca
Brachidontes citrinus
B. exustus
Cuspidaria costellata

Chama congregata
C. florida
C. macerophylla
C. sinuosa
Chione cancellata
C. grus
C. mazycki
C. pygmaea
Chlamys benedicti
C. imbricata
C. multisguamata
C. ornata
Codakia costata
C. orbicularis
C. orbiculata
C. pectinella
C. portoricana
Congeria leucophaeta
Coralloiphaga coralloiphaga
Corbula operculata
Crassinella guadeloupensis
C. lunulata
Cumingia coarctata
Cyathodonta cruziana
Diplodonta punctata
Divaricella dentata
D. quadrisulcata
Donax denticulata
Echinochama archinella
Ervilia nitens
Glycymeris decussata
G. pectinata
G. undata
Gouldia cerina
G. insularis
Isognomon alatus
I. bicolor
I. radiatus
Laevicardium laevigatum
L. l. sybariticum
L. mortoni
Lima pellucida
L. lima
L. scabra
L. tenera
Limea bronniana
Lioberus castaneus
Lithophaga antillarum
L. bisulcata
L. nigra
Lucina multilineata
L. pensylvanica
L. radians
L. trisulcata blandus
Lysonsia beana
Lyropecten antillarum
L. nodosus
Macoma brevifrons
M. constricta
M. tenta
Macrocallista maculata
Mactra fragilis
Modiolus americanus
Mulina lateralis
Musculus lateralis
Ostraea frons
Papyridea semisulcata
P. soleniformis
Pecten ziczac
Petricola lapicida
Phacoides pectinatus
Pholadomya candida
Pinctata radiata
Pinna rudis
Pitar albida
P. aresta
P. circinnata
P. fulminata
Plicatula gibbosa
P. sp?
Pododesmus rudis
Pseudochama radians variegata
Pteria colymbus
Quadrans lintea
Rocellaria cuneiformis
R. ovata
Semele bellastriata
S. nuculoides
S. proficua
S. proficua radiata
Solemya occidentalis
Solecurtus cummingia

S. sancta-marthae
Spengleria rostrata
Spondylus americanus
Strigilla carnaria
S. mirabilis
S. piciformis
Tagelus plebeius
T. divisus
Tellina alternata
T. candeana
T. crystallina
T. cuneata
T. interrupta
T. guildingii
T. laevigata
T. promera
T. similis
T. sybaritica
T. versicolor
Thyasira trisinuata
Tivela abaconis
Trachycardium isocardia
T. magnum
Transenella cubaniana
T. culebrana
Trigonicardia antillarum
Venericardia tridentata

EIGHT NEW SPECIES OF LAND SNAILS FROM THE SOUTHERN UNITED STATES

By LESLIE HUBRICHT

(Concluded from July no.)

Succinea indiana lives in places which are so dry that no other species of native land snail can survive there. Not only can it withstand sun and drought, but the ravages of roadgraders and bulldozers as well. Below the Clark Hill Dam, it is found abundant on land from which some twenty feet of earth had been removed during the construction of the dam. Land that even the weeds did not find entirely hospitable. At this locality the snails were heavily infested with *leucochloridium*. Every specimen opened contained larvae or sporocysts.

Succinea campestris Say

Succinea campestris Say, 1817 Jour. Acad. Nat. Sci. Phila *1:* 281.

Succinea campestris vagans Pilsbry, 1900, Naut. *14:* 74.

Quickella vagans (Pilsbry), Pilsbry, 1948; Land Moll. N. Amer. *II*, p. 843, figs. 443d.

An examination of the shells of the type lot of *Succinea campestris vagans* Pilsbry, disclosed that it was a mixture of two species of shells. One species, of which there were 5 or 6 specimens, had a very short spire, large aperture and almost hyaline shell, and were not distinguishable from shells of *Succinea campestris* Say of the same size. The remaining shells, of which there were 25 to 30, were smaller, with longer spire and smaller aperture. These were not distinguishable from *Catinella vermeta* (Say) of the same size. Pilsbry's original description was clearly

based on the shells of *S. campestris*. Later, when he described the animal, he used the animals of *C. vermeta*. Since the original description was based on shells of *C. campestris*, the name *vagans* must be placed in the synonomy of that species.

Succineids become sexually mature when very small. After they have mated they will add at least a full whorl to the shell. Dr. Pilsbry, apparently, was not aware of this, as *vagens* was distinguished from *campestris* only by its smaller size and fewer whorls.

CATINELLA TEXANA, new species. Pl. 4, figs. F to H; text-fig. 1, F to H.

Shell pale golden-brown in color, translucent, rather dull, with about four whorls, elongate-ovate, sculpture of unevenly spaced growth wrinkles. Spire acute, long, sutures well marked, whorls well rounded. Aperture ovate, occupying about 58% of the length of the shell, outer and basal margins well rounded. Columella nearly straight.

Mantle and sides of foot covered with a dark gray flecking. Hermaphrodite duct well pigmented. Talon strongly pigmented, almost black; club-shaped and undivided but with a terminal notch. Prostate gland large, oval and unpigmented. Vas deferens not very long, entering the penis at the apex. Penis rather broad unpigmented, with a large pouch, connected near the base on the anterior side. There is no trace of a sheath. Penial retractor connected to the side of the penis near the middle. Spermatheca large, globose, duct slender.

Height	Diameter	Ap. H.	Ap. W.	
13.3 mm.	6.7 mm.	7.7 mm.	5.0 mm.	Holotype.
13.3 mm.	7.3 mm.	8.3 mm.	5.7 mm.	Paratype.
10.8 mm.	6.0 mm.	6.3 mm.	4.0 mm.	Paratype.

Type Locality.—*Texas:* Milan Co.: near small spring, near Brazos River, 4.7 miles northeast of Gause, holotype 205892 and paratypes 205891 U.M.M.Z., other paratypes 15427, collection of the author.

Catinella texana is most closely related to *Catinella vermeta* (Say), differing in having a more slender shell, and in having the appendix basal rather than in the middle of the penis.

CATINELLA PUGILATOR, new species. Pl. 4, figs. I to K; text-figs. 1, D & E.

Shell straw-yellow, translucent, shining, oblong-ovate, with about three whorls, sculpture of fine growth wrinkles. Spire rather short, sutures moderately impressed, whorls convex. Aperture ovate, occupying about 68% of the length of the shell, outer

and basal margins well rounded. Columella nearly straight.

Mantle gray, overlayed with black blotches. Hermaphrodite duct well pigmented. Talon moderately pigmented, club-shaped, with a terminal notch. Prostate gland rather large, somewhat rectangular in shape, lightly pigmented. Vas deferens rather long, slender, abruptly enlarging before it enters the penis, entering the penis at the apex. Penis broad, unpigmented, with a small thumb-like appendix near the center of the posterior side. There is no trace of a sheath. Penial retractor connected to the anterior side of the penis near the middle and to the thickened portion of the vas deferens. Spermatheca rather large, globose, duct rather short, thick. Atrium and vagina very short.

Height	Diameter	Ap. H.	Ap. W.	
13.2 mm.	7.1 mm.	9.3 mm.	5.1 mm.	Holotype.
11.1 mm.	6.0 mm.	7.8 mm.	4.7 mm.	Paratype.
10.3 mm.	5.3 mm.	7.0 mm.	4.0 mm.	Paratype.

Type Locality.—*North Carolina:* Currituck Co.: salt marsh, 0.5 mile south of Maple, holotype 205889 and paratypes 20589D U.M.M.Z., other paratypes 20980, collection of the author.

Catinella pugilator resembles *C. hubrichti* Grimm in its *Oxyloma*-like shell, but differs in its boxing-glove shaped penis. The very small penial appendix plus the thick spermatheca duct will readily separate this species from all other described species.

VERTIGO TESKEYAE, new species. Text-fig. 2.

Shell ovate, dark chestnut, with about five whorls. Spire convexly conic, with obtuse summit; whorls increasing rapidly, the last much the largest, its height equal to almost two-thirds of the shell, sculpture of fine irregular growth lines. Lip thin and expanded, with a distinct crest behind it. Aperture with a distinct sinulus. Parietal lamella rather strong, about twice as long as high; angular lamella small; an infraparietal tubercle is never present. Columellar lamella strong, horizontal, located in about the center of the columella. Basal fold variable, rarely very large, often nearly obsolete, located on the end of a callous ridge which extends along the basal and lower outer walls just inside of the lip. Infrapalatal tubercle often present, although usually very small. Lower palatal fold moderately well developed, upper palatal fold somewhat smaller. Suprapalatal fold never present.

Height	Diameter	Whorls	
2.6 mm.	1.6 mm.	5	Holotype.
2.1 mm.	1.5 mm.	4	Chocowinity. (smallest)
2.9 mm.	1.8 mm.	5	Lightwoodknot Creek. (largest)

Distribution—*Maryland:* Dorchester Co.: subfossil, near beach, 0.5 mile south of Elliott. *North Carolina:* Camden Co.: swamp, 1

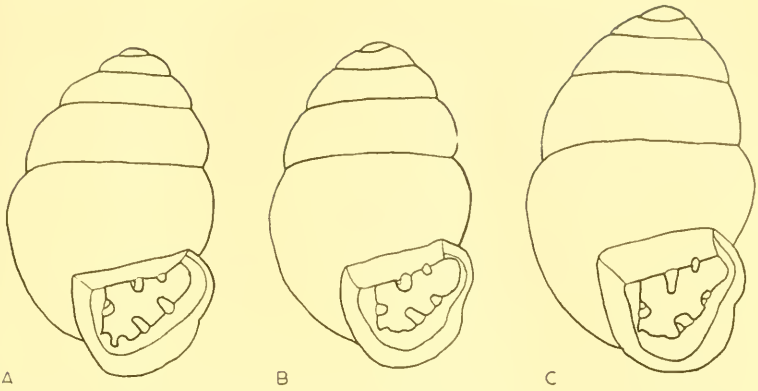

Figure 2. *Vertigo teskeyae:* A, holotype. B, paratype. C, from Lightwoodknot Creek.

mile south of South Mills. Gates Co.: near Bennetts Creek, Gatesville. Chowan Co.: swamp, 1.2 miles south of St. Johns. Beaufort Co.: swamp, 4.8 miles north of Pantego; near Pamlico River, opposite, Washington; swamp, 1.4 miles northeast of Chocowinity. Craven Co.: near Little Creek, 1 mile north of Askin; swamp, 1.8 miles south of Vanceboro. Columbus Co.: bank of canal, west side of Lake Waccamaw, holotype 205903 and paratypes 205904 U.M.M.Z., other paratypes 20870, collection of the author. *South Carolina:* Williamsburg Co.: near Black Mingo Creek, north of Rhems. *Georgia:* Screven Co.: near Brier Creek, 10 miles east-northeast of Sylvania. Toombs Co.: swamp, 6.5 miles south of Parkers. *Florida:* Flagler Co.: near Pellicer Creek, 13.5 miles north of Brunnell. Holmes Co.: low woods, 2.5 miles west-northwest of Sweet Gum Head. *Alabama:* Montgomery Co.: low woods, 0.5 mile north of Mt. Meigs. Covington Co.: near Lightwoodknot Creek, 3.7 miles west of Opp. *Mississippi:* Warren Co.: low woods, near Big Black River, 6.2 miles east-northeast of Bovina.

Vertigo teskeyae is most closely related to *V. ovata* Say, from which it may be readily distinguished by its distinctly darker color (when fresh), larger size, and fewer teeth. The infraparietal and suprapalatal tubercles are never present. The columellar lamella is horizontal, not sloping upward, and is lower in position on the columella. The basal fold is smaller and is lower down. The aperture is much more open than is usual in *V. ovata*. *V. teskeyae* is the largest *Vertigo* known from the southeastern United States. It is a species of the southern Atlantic and Gulf Coastal Plains. In North Carolina, it is found crawling on the

wet mud and debris of swamps. Farther south it may be found on the undersides of palmetto leaves in company with *Pupisoma.* It is frequently found associated with *V. ovata.*

Vertigo teskeyae is named in honor of Mrs. Margaret C. Teskey, in recognition of her services in behalf of the American Malacological Union.

PUERTO RICAN CAMAENIDAE

By H. BURRINGTON BAKER

The symbols used for Puerto Rican localities were explained recently (1961).

Caracolus carocolla (Linné). Under leaves on ground when dry, but fair climber on tree trunks, up to 10 ft. around El Yunque; En, Er, En3,4, Jn, Pn, Pr, Wn, Wr, Ws (dead); everywhere except in driest places; not even empty shells recorded from Ps or Ww; 0-4000 ft. Animal (added to Wurtz, 1955:112) sluggish; foot large, with sides varying from slate color to dark chestnut with buff spots; all tentacles dark; sole trizonal, with coarse waves.

The obsolete name *Helix arecibensis* Pfeiffer, 1856, evidently was based on a juvenile shell of *Caracolus,* probably this species.

Caracolus marginella (Gmelin). Very good climber on tree trunks, nearly subarboreal, often seen 15-20 ft. above ground; Ee, En, Es, Jn, Pn, Wn; mainly on lowlands, especially near cultivation; not seen above 1500 ft. in Luquillo Mts. or in the eastern Cordillera Central (Pr). Animal dorsally almost black, but shading into whitish near sole; ommatophores dark but eyes darker. Uniformly light greenish shells with whitish animals (Jnl, near which "albinos" were found in 1864, v. Bland, 1875:80).

CARACOLUS MARGINELLA MAYAGUEZI, new subspecies.

Pleurodonte bornii (Pfr.) Pilsbry, 1889 (6b):127, in part, pl. 56, fig. 6 type (ANSP. 20861) from Swift Collection, labeled "Mayaguez." Type locality (the older collectors often gave the nearest port): top of Pico Montoso, near Maricao, elevation 2300 ft. (Wr2), where shells match Pilsbry's figs. very closely. Shell differs from typical *C. marginella* by its broader dark zones, which on the apical side restrict paler to narrow, sutural and carinal zones. Also found: Maricao Forest (Wr3), near Cabo Rojo (Ws) and near Guanica Bay (Ps1), 0-3000 ft. Also noted by Bland, 1875:80.

All shells collected further east, including those around mouth of Rio Guajataca (Wn), which slightly approach *mayaguezi,*

are quite typical *marginella.* Probably the 2 forms intergrade, since the typical one thrives in lowland, cultivated places; in fact, from field notes, I saw living *"marginella"* (which form?) on trees in the garden of the Agricultural Station in Mayaguez.

Polydontes (Luquillia) luquillensis (Shuttleworth). Adults on trunks of trees, 5-12 ft. up, but young (looking like those of *P. lima)* usually on ground; Luquillo Mts., above 2000 ft., where it replaces the "closely allied" *P. lima.* Animal bright ochraceous (but one almost white); eye and inferior tentacles almost black; sole blackish slate.

Although these lots show considerable variation in banding and height (Cf. Pilsbry, 1889 (2) :pl. 7, figs. 63, 64) none matches that of van der Schalie, 1948:pl. 6, fig. 9, which seems immature and weather worn. Despite considerable differences in its later whorls, *Granodomus* Pilsbry, 1931, seems only a section of the subgenus *Luquillia* Crosse, 1892 (Cf. Wurtz, 1955:132).

Polydontes (Granodomus) lima (Férussac, 1821) Fair climber on tree trunks and brush, but less so than *C. marginella;* especially common near cultivation; Ee2, Es, Jn, Js, Ps2 (dead), Wn, Ws (1 shell form *castrensis*), Ww; lowlands. Secretes quantities of disagreeable mucus; seen in reciprocal copulation. ANSP. 1125 (from Bland, without exact locality) contains 2 shells of form *castrensis* and one of subspecies *maricao;* see Pilsbry, 1889 (6b) :pl. 1, figs. 3 (*castrensis*) and 4 (*maricao*).

P. (G.) lima maricao Clench. Apparently climbs less than typical *lima;* Prl-3, Wr2,3; Cordillera Central, 2500-4000 ft.

Dr. van der Schalie's (1948:79) nice "curves" show long and careful study, but is a "random sample" from a large area actually possible? Might not the "normal distribution" of his composite one be due to his larger series, as shown by his maps, of shells from lower altitudes? If based on enough animals, that from over 1500 ft. may be significantly bimodal, and the habitat of typical *maricao* seems considerably higher.

My lots of *P. lima maricao* often show less prominently the peripheral brown band and sometimes additional, finer ones like the larger shells from the Virgin and Leeward Islands. For this reason, in part, the very involved nomenclature of the latter is outlined. Perhaps, *maricao* and *asperula* may be "microspecies," and "typical" *lima,* which thrives in cultivated areas, might consist of very unstable hybrids between them?

P. (G.) LIMA, VAR. (?) INCERTA ("Fér." Beck) or (Férussac).

Helix incerta Férussac, 1823, livr. 18:pl. 105, figs. 2 (named on cover?). *(Helix) Otala incerta* Beck, 1837:36, from Lesser Antilles (sic), founded on figs. cited. Not *Helix incerta* Draparnaud, 1805. (?) *H. incerta* Pfeiffer, 1841, Symb. Hist. Helic.:37, from St. Thomas.

Dr. Pilsbry and I always disagreed on the delicate question as to whether Beck's name should be preoccupied in his genus *Helix,* or only in his subgenus *Otala,* but Beck himself, 1837a, when he added description to a few of his nude names, regularly used his genus or its initial; e.g., *Nanina (Microcystis) ornatella* (p. 2). In any case, *"incerta"* should be returned to the synonymic oblivion, from which Pfr. snatched it. The Philadelphia Acad. Nat. Sci. has 3 lots of the fossils from St. Thomas (ANSP. 1033 from Bland) and I agree with R. Swift (Mss. in ANSP. 30634 from St. John I., and in 30636 from St. Thomas) that Férussac's figures look most like one, worn, deformed shell of *P. lima.* The apparently dark band of his left fig. is absent from his right one and Deshayes made no mention of it.

P. (G.) LIMA ASPERULA (Beck).

Helix lima, var. notab. (sic) Férussac, 1832, livr. 22, Explic. pls. livr. 22-27: p. ij; livr. 24, pl. 46a, figs. 4 & 5 [copied by Pilsbry, 1889 (2):pl. 4, figs. 36 & 37]; certainly not a valid name. *(Helix) Otala asperula* Beck, 1837:36, founded solely on figs. cited above, from Curacao (sic), but with *H. Hgen. lima* var. *notabilior* Fér., in synonymy. *Helix notabilis* Shuttleworth, 1854:40, partly founded on figs. cited above, from Is. San Juan (St. John) and Anegada, and with *Helix lima* var. *notabilis* Fér. cited. *Thelidomus notabilis* (Sh.) Pilsbry, 1889 (6b) & 1890 (5b): pl. 1, fig. 1 (ANSP. 1047, Tortola, from Thos. Bland) and var., pl. 1, fig. 1 [ANSP. 30634, labeled as from San Jan (St. John I.) by Krebs (from Swift Collection)].

Since they all are founded on exactly the same figures, I now select Férussac's fig. 4 (the adult, cited above) as representing the type shell, and Tortola, Virgin Islands, as the type locality of notab. Fér., *asperula* Beck and *notabilior* Beck. The ANSP. lots from St. John Island (now designated as type locality of *H. notabilis* Sh.) seem usually a little thinner and more commonly have additional bands above and below periphery, but intergrade.

Incidentally, all the records of *"incerta"* (actually *asperula*) from Puerto Rico are due to Kreb's label of "San Jan," which

I certainly (and probably Pilsbry) took to be a misspelling of San Juan, Puerto Rico, where *asperula* does not occur. To add to the confusion, the principal town of Antigua apparently was named after the same saint, and shells similar to the Tortola form in banding, but thinner (like those from St. John I.) lived on St. Bartholomew (ANSP. 1051 from Bland), which also is in the Leeward Islands. Anegada (ANSP. 1049 from Bland) is another Virgin I. Finally, one shell (ANSP. 30628 from W. G. Binney) is labeled Martinique, and looks like the Tortola form.

Polydontes (Parthena) acutangula (Burrows). Adults truly arboreal, but young animals often found under leaves on ground; En1, Er, Es4, Jan1, Pn2 (long dead), Pr1; 0-3400 ft. east of San Juan, but westward only found living at 4000 ft. Green mantle of adults showing through shell, but young ones ochraceous brown. Animal (added to Wurtz, 1955:112) incapable of withdrawal into shell, extending out to 8 inches (20 cm.) long, including about 1½ inches of tentacles, but mantle only extending slightly over columella; tail long, angulate dorsally with median groove; sides of foot becoming brownish near sole; ommatophores darkish slate; inferior tentacles lighter; mantle collar orange-brown; mucus yellow; seen in reciprocal copulation on trees.

Van der Schalie, 1948:82, obtained another camaenid, *Zachrysia auricoma havanensis* Pilsbry, a Cuban species.

Additional references (See 1961)

Baker, H. Burrington. 1961 (1), Naut. *74*:142. 1961 (3),, Naut. *75*:33.

Beck, H. 1837, Index molluscorum, etc.: 1-124.

—— 1837a, Specierum novarum, etc.:1-8.

Wurtz, Charles B. 1955, Proc. Acad. Nat. Sci. Philadelphia *107*:99-143, pls. 1-19.

ADULT LIVING SPECIMEN OF PAPUINA FERUSSACI

By J. B. HENRARD
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To identify *Papuina ferussaci* (Lesson), I looked up the history of the species and its whereabouts. The description, published in 1831, is rather short but sufficient; moreover a figure was given by him. Unfortunately his type specimen is probably lost, Tapparone Canefri tried in vain to locate it in the museum at Paris. Pfeiffer, who had in 1848 to deal with the species,

could only copy the description in his Mon.Hel.Viv., p.231, but in the year 1868, in Vol. 5. of his Monograph, he identified material from Cumming's collection as being Lesson's species and gave a new description of his own. This new description, however, was in many important characters, very different from the original one. Tapparone recognized the error and demonstrated convincingly in the year 1883, that Pfeiffer's so-called *Helix férussaci,* both the description and the colored plate in the Novitates Conch. tab.56 fig. 7-9, was a characteristic new species and named it *Helix exsultans.* In the well-known Manual of Conch. Vol. 7, p.30, f.51 the true species of Lesson was placed by Pilsbry in the genus *Papuina;* he gave a good description, taken from the original one and from the plate. This description runs as follows: "Shell imperforate, trochiform, deep-chestnut, with a golden-yellow line at the carina, and ascending the spire to the apex, whorls 6, completely flat, the apex is enlarged, convex; the last whorl has a salient acute carina. Aperture much depressed, triangular, wider than high, very acute at the junction of the appressed basal lips; peristome reflexed, sinuous at the angle."

In the year 1933, Lesson's species was mentioned by Madame v. Benthem Jutting on the list of all the species of the genus *Papuina,* known at that time. This important and useful list was published in the periodical Nova Guinea, Vol. 17 (Zoölogy) Livr. 1, p. 411. She placed in it var. *exsultans* (Tapp. Canefri), the color being much diluted to cinnamon. Because this color is the typical one of Tapparone's species, the identification, in my opinion is probably correct.

The most recent mention of *Papuina ferussaci* is given by Adam and Leloup in Vol. 2, p.29 (Mus. Roy. Sc. Hist. Nat.) in the year 1939, together with fig. 16 on Plate 2. The only specimen they had, was found in 1929 near Manokwari, which is the modern name of the type locality, Port Dorey of Lesson. Their specimen was in bad condition, worn and nearly totally bleached, but with the yellow keel still present at the base of the shell and with the typical brown color. I agree with both authors that their specimen belongs to the true *P. ferussaci* of Lesson, after comparison with their figure 16. Since that time, no further data are known to me.

In the year 1949, Father Rombouts, a missionary at Sorong,

told me that he would penetrate what he called the Aifat Anoek Tifa Region, in the northeast part of "The Vogelkop," to visit some papua-settlements. Because he was much interested in natural history and the region was never visited by collectors, I asked him if he could give some attention to living land-mollusks. He promised to do that. Although he was obliged to return earlier, on account of the unkind and hostile natives, he collected a very interesting lot. Upon his arrival home, he handed the specimens to me and we examined them together. Among them there were species I had already found myself, but others were quite new to me; among them was a very beautiful species of *Papuina,* the subject of this paper.

Pointing to this *Papuina* Father Rombouts said: "This one must be very rare and I found it so beautiful, that I tried to find some more, but could not obtain another one."

All the characters, given by Lesson and from the translation by Pilsbry, given above, agree perfectly with this specimen. Lesson mentioned, however, only the general and easily recognizable ones, so that the more subtle ones (mostly visible under a strong lens) are wanting in his description. I give here an additional description of my specimen.

High trochiform shell, somewhat higher in proportion to the width, dark castaneous, the faintly convex base shining, whereas the whorls above the very sharp keel are of a dull color. Whorls nearly totally flat, only very slightly concave to their lower sutures, the profile very different from those of the allied species *P. exsultans* (Tapp.) and *P. pythonissa* (Tapp.). Keel with a golden-yellow, ½ mm broad band, visible also along the sutures and below the keel. The common oblique growth-lines very distinct, under a strong lens; the whorls, especially the lower one, with about 5 regular spiral-lines, base radiately striated, towards the umbilical region somewhat deeper and wider grooved. Whorls just below the suture slightly darker colored, forming on the ultimate one a faint, not sharply defined zone. Apex somewhat darker colored. Umbilicus a faint perforation, obtected by the columellar margin. Peristome darker, more blackish-brown and the aperture provided within with a grayish-white, rather sharply defined margin, the inner part of the aperture brown. Columellar margin rather broadly reflexed and provided at its base with a distinct, although small tooth-like pale projection, the columella passing rather bluntly to the nearly straight lower margin of the peristome; outer margin of the peristome beaked, with a sharp keel.

The small columellar tooth, mentioned in my description, was not indicated by Lesson and, in the lithographic picture by the artist, this character did not show fully. Moreover, the dimensions are not indicated on Lesson's plate. In the description the diameter is given as 11 lines; accepted as French lines, this becomes 24.8 mm, and my specimen measures 28.2 mm. My shell is therefore somewhat larger. Because, however, in many species of the genus *Papuina,* there occur fluctuations in the dimensions, there is, for the time being, no reason to accept a special variety for my larger one.

Pilsbry placed *P. ferussaci* in his 6th group, the "Group of the *P. pileolus.*" He characterized this group as "subperforate or imperforate, pyramidal, sharply keeled and flat at the base." Unfortunately, many species, mentioned by him, were not sufficiently known to him, especially if there were no figures, and this group is very heterogeneous. *P. leonardi* (Tapp.) and *P. turris* (Adams) are not sharply keeled at the base; they do not belong to this group. The former certainly belongs to the 5th group of Pilsbry, called: "the group of the *P. antiqua.*" This also was recognized by Madame v. Benthem Jutting, who accepted *P. leonardi* simply as a synonym of *P. antiqua* (Adams & Reeves), in the list of the species of *Papuina* in Nova Guinea Vol. 17, cited above p. 121. *Papina turris* (H. Adams) has only a compressed last whorl with a very blunt keel and must be eliminated also. The remaining species of the group are, as to form and outline, very different and it is thus very heterogeneous. We can, however, divide the group easily into two homogeneous ones, if we accept for the true "group of the *P. pileolus*" only the low-spired species without a subcolumellar tooth, viz. *P. pileolus* (Férussac), *P. rhynchostoma* (Pfeiffer) and *P. fergusoni* (H. Adams). The other group, containing high-spired species with a very distinct subcolumeller tooth is to accept as the "group of the *P. ferussaci.*"

The new group is not only very homogeneous but, moreover, zoogeographically sharply limited, because all the species, belonging to this group, inhabit the northwest part of Dutch New Guinea. All its members are represented in my collection. I shall summarize them afterwards more in detail in another paper.

AN EXCURSION TO LAKE MIRAGOANE, HAITI

By WALTER JACOB EYERDAM

Lake Miragoane in the southwest peninsula of Haiti is a small muddy lake which is about three square miles in area and lies near the coast about half-way between the towns of Petit Goave and Miragoane, approximately 60 miles on the road west of Port-au-Prince. It is the largest fresh-water lake in Haiti and its vicinty is sparsely populated. There are two other large lakes on Hispaniola which are several hundred square miles in area which are saline and were originally inlets of the Gulf of Haiti in geological times. These are the Etang Saumatre and the Lac Enriquilla (150 ft. below sea level), both of which lie due east of Port-au-Prince about 50 miles. The latter lake is all within the Dominican border.

In 1927 while collecting plants and land snails for the Smithsonian institution and reptiles for Dr. Thomas Barbour in the southwestern peninsula of Haiti and the islands of Gonave and Grande Cayemite, I also made a special effort to collect all the freshwater shells that could be found. More than 1000 lots of land shells were collected and sent to Dr. Bartsch. Most of them were taken alive or in a good condition. For one thing I found that Haiti compares in no manner with Cuba in richness of its land shell fauna. There is only one species of *Liguus,* and only a very few species of *Cerion* and *Urocoptis,* of which there are many hundreds of species in Cuba. The only family of land snails that seems fairly well represented is the Annulariidae.

There are many areas, some of which are of considerable extent where snails are exceedingly scarce. The topography of Haiti is very rough and mountainous with more than 3,000,000 people of which over 99 percent are negro. Most of the population are peasants.

It was my good fortune to team up with the great Swedish botanist, and naturalist, Dr. Erik Ekman, the foremost authority on Caribbean plants who knew intimately the flora of Cuba and Haiti. Before he died in the Dominican Republic in 1930, he had discovered over 2,000 new species of plants in Cuba and Haiti during his 20 years of botanical rambles.

I spent nearly 5 months in hard marches and almost con-

tinuous biological collecting with Ekman, who would quickly drop a companion if he couldn't keep up with his pace and live the primitive life to which he had adapted himself. We never hired natives or pack animals and we carried all our supplies on our own backs; we lived on native food, drank water wherever it could be found, often from stinking pools; we shot birds, stuffed the skins, and ate the meat. Guinea fowl are abundant in some areas and the natives seldom molest them. Haitian peasants are usually very poor, but invariably hospitable, so generally we slept in native huts while collecting in the mountains and islands.

At that time the American Marines still occupied Haiti because of the Caco rebellion a few years before. Ekman, a very eccentric man who cared nothing about formalities and hated shams or snobbishness was, nevertheless, a very learned man and a delightful companion. He was well posted on a wide variety of subjects, was conversant in all the native dialects and could speak at least 8 European languages. He was known personally throughout Haiti by much of the peasantry, the military officers and by the president. The American Marine officers called him the "Iron Man of Haiti" or the "Crazy Swede," because very few men had the stamina and drive to keep up a continual pace of hard marches into the rough jungles and live on native food and sleep wherever he happened to be when darkness fell.

Our regular routine was to be up at 4 A.M., start off immediately, but without a breakfast, eat a few mangoes or wild fruits if we found them, or purchase a couple of pennies' worth from peasants during the day, and at sundown we usually had a dish of rice and a boiled fowl and Haitian hard tack with plenty of tea and sugar, around a small campfire.

Lake Miragoane is quite round and has a very muddy bottom of unknown depth. It is completely surrounded by reeds and dangerously deep mud. The flora is particularly interesting around the outlet of the lake. A large waterlily grows here with stems 12 to 15 feet long. Ekman always knew right away when he found a new species of plant and was almost always correct. Here I found a new fern and a duckweed. Numerous species of ferns a nd several beautiful species of Canna grew

in the swamp. While Ekman and I gazed longingly at the lake and contemplated its floristic possibilities for our botanical collection, wondering how to find an area where we would not disappear into the treacherous mud, we finally found a small boy, who had a hollowed out log boat, and who agreed to take us where we wanted to go. He paddled and poled the boat along the margin of the lake until an ample series of desired plants was made. The marsh around the lake, and the surface of the water, was a regular aviary of interesting birds. Glossy ibis, two kinds of egrets, several species of ducks, four kinds of herons, the blue, the green, the Louisiana and night herons, were there. Curlew, yellowlegs, grebes, coots and sandpipers and the curious jacanas, skipping and running about on the lily pads after insects. To a real ornithologist or a naturalist with proper equipment and plenty of time, this lake has a great deal of interest.

On this special excursion we asked the little boy to put us ashore on the margin of the lake of the opposite side. There the mud appeared firm enough to walk on through the marsh to the land. The objective was some rare species of ferns and grasses that could be seen from the lake. The boy left us, and we went our way to the shore. Soon we started to break through the mud crust, and were floundering around in the deep ooze for some time, often falling through the upper crust only to become more deeply mired. We began to grow quite anxious as to how we should get back to safer ground, and out of the swamp. Suddenly we came upon a black woman intently engaged in setting snares for wild fowl. She hadn't noticed us at all until we were almost upon her when she became terribly frightened at our appearance out of the mud. She screamed and tried to run away, but, after a small gift of a few cigarettes, she calmed down and showed us a sort of path out of the big swamp. It was really a lifesaver for us.

Upon gaining safer ground on the lake shore, I found a few spots in shallow water inhabited by mollusks. During about one half hour, spent searching for freshwater shells, I collected the following species, from which Dr. Clench (1936) and Clench & Aguayo (1937) named a subgenus and 4 forms.

Physa (Haitia) elegans Dr. Clench. Made type of a subgenus,

because not closely related to the other forms in the West Indies.
Helisoma eyerdami Clench and Aguayo.
Helisoma caribaea (Orbigny)
Tropicorbis pallida (C. B. Adams)
Tropicorbis albicans (Pfeiffer)
Drepanotrema cimex (Moricand)
Drepanotrema anatinum (Orbigny)
Potamopyrgus coronatus ariomus Clench & Aguayo.
Ferrissia (Laevapex) *haitiana* Clench & Aguayo.

Up to that time, less than 50 species of freshwater shells were known from the West Indies and Bahama islands.

Later in the afternoon, we found a beautiful waterfall where we had a delightful bath, collected some rare plants and snails, and I also collected a rare frog, *Eleotherodactylus inoptatus* (Barbour) and a rare snake *Uromacer oxyrhynchys* (Dumeril and Bibron).

Several times before I had come alone to the south side of the lake to collect specimens. There in the jungles many fine land snails were taken, including *Bulimulus, Cepolis* and *Caracolus,* and a colony of *Liguus virgineus* on the lignum vitae and logwood trees yielded several hundred fine specimens. On the ground, amongst these trees, I also collected scorpions, tarantulas, centipedes and several specimens of the giant Haitian armoured millepede, over 8 inches long and about one inch thick. When disturbed it sprays acid at its enemies a distance of more than a foot. The substance is exuded from pores along the sides. It smells and burns like sulphuric and prussic acid. I did not realize how dangerous these creatures could be with careless handling until I met Dr. Cook, American specialist of palm trees, centipedes and millipedes a few days afterward in Port-au-Prince. Most of the skin of one side of his face was burned off, and his helper had one of his hands badly burned as a result of heedless collecting of these large millipedes.

No serious work has ever been done in collecting the fauna of lake Miragoane except a casual excursion made by Dr. Wm. Beebe in 1927 a few weeks before I came to Haiti when he discovered two new endemic fishes. One of them, a tiny guppy about ¼ inch long, fully grown, was rather common in a ditch near the lake. With its high degree of endemism, a careful collecting survey of its limnological fauna by a couple of

competent biologists should bring to light a surprising number of new and interesting species of animals.

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APPARENT GEOTACTIC BEHAVIOR IN PHYSA

By ANDREW McCLARY

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This note describes an experiment in which snails of the genus *Physa,* identified as *P. integra* Haldeman[1], were tested for geotactic behavior in a mud medium.

Method. Six populations of *P. integra,* collected from the locations given in Table 1, were used in the study. Experiments were conducted between September 25 and October 8, 1960. Each population was collected early on a given day, and tested in the afternoon or evening of the same day. The medium in which the snails were tested was a silty mud obtained from the banks of the Milwaukee River at Estabrook Park, on the north side of the city of Milwaukee. The populations designated as "2", "4" and "5" in Table 1 were collected in the same area as the mud. The mud was washed in tap water, sieved through a fine mesh screen, and allowed to dry to a tacky consistency. Some oligochaetes of the family Tubificidae were present in the mud after sieving; no other forms of life were obvious. Before testing a given population, tap water was added to a portion of the mud, which was then used in the test as described below. In some cases, the mud utilized had been employed in previous tests, in other cases, fresh mud was used.

Twenty snails were selected at random from the population to be tested, each snail being measured at the time of selection. The average shell length of the animals used was about 7mm. Each snail was placed alone in a 150 ml. glass beaker filled to a level of 4mm. with mud. Although the orientation of the snails was not controlled, most animals appeared to land in an upright postion. Care was taken to place the snails in the

[1] The writer wishes to thank Dr. H. van der Schalie, Museum of Zoology, University of Michigan, for kindly identifying the specimens.

middle of the mud surface. Mud was then added over the snail in each beaker to form a mud column totaling 50mm. in height. The mud column was typically of a consistency such that after a half hour approximately 5mm. of water had collected above its surafce. At the start of a test, each snail was therefore immersed in a mud medium at an approximate distance of 4mm. from the beaker floor, 25mm. from the beaker wall, and 45mm. from the mud surface. The 20 beakers were then placed on a table 4 feet below a 100 watt lamp. Room temperature during the tests ranged from 19-22°C. Beakers were inspected at 5 minute intervals, mud surface, beaker wall, and beaker floor being watched for the appearance of snails. As the mud medium was homogeneous in texture, snails appearing could readily be identified. Each beaker was observed for a period of two hours. If a snail had not appeared by the end of this period, its position in the mud was ascertained by probing.

Results. Of the total of 120 snails used in the experiment, 61 surfaced on the mud. Surfacing usually occurred at a point roughly between the center of the beaker and the beaker wall so that, assuming travel in a straight line, the 61 snails moved towards the surface along a path that was at an average angle of 70° from the horizontal. The average time lapse between start of a run and surface appearance was 42 minutes. Eight of the 120 snails were recorded as appearing at beaker walls at points ranging from half way up the beaker wall to just below the mud surface. Again assuming travel along a straight line, snails moving towards a beaker wall did so along a path that was at an average angle of 50° from the horizontal. Average time lapse between start of a run and appearance at a beaker wall was 63 minutes. Fifty-one of the 102 test snails did not appear at either the surface or the wall of a beaker. Probing indicated that 15 of these had moved up through the mud medium, having traveled from 1/3 to 1/2 the distance to the surface. The remaining 36 snails were found to be in approximately the location where they had been placed at the start of the two-hour period.

Snail size did not appear to be a significant factor in the behavior shown. The consistency of the mud medium differed slightly between tests, and this may have been a partial cause

of the behavior variations found between populations. Possibly also more exact tests would reveal actual behavior differences between snails of different populations.

A summary of the results is given in Table 1.

Table 1

Behavior of Physa in a Mud Medium

Population Number	Date Tested	No. of Snails Recovered in Each of Four Locations				
		Mud Surface	Part Way to Surface	Beaker Wall	Original Location	Total
1	9-25-60	8	2	0	10	20
2	9-30-60	14	3	1	2	20
3	10-2-60	11	2	1	6	20
4	10-7-60	12	2	2	4	20
5	10-8-60	9	1	2	8	20
6	10-8-60	7	5	2	6	20
Total		61	15	8	36	120

Collection sites of populations were as follows. 1: Aquarium in Botany Department at University of Wisconsin--Milwaukee. 2, 4, 5: Milwaukee River bank at Estabrook Park, Milwaukee County. 3: Stone fountain at Whitnall Park, Milwaukee County. 6: Stream at Kletzsch Park, Milwaukee County.

Discussion. Possibly vertical gradients involving physical-chemical properties exist in a mud medium and serve to guide an immersed snail to the surface of the mud. Gradients of this type might conceivably involve differences in temperature, light, oxygen, or in the concentration of various organic or inorganic materials in the mud.

An alternate, and perhaps more likely, explanation of the upward movement of the snails in the present experiment is that the mud itself provided no cue as to direction, but that the movement was a true geotactic behavior, or response to gravity.

Snails are usually considered to orient to gravity either by statocysts, organs designed to ascertain position in space; or by proprioceptors, sensitive to the differential stresses in muscle which occur in an organism subjected to the pull of gravity (Carthy, 1958).

While statocysts are present in snails (Bouvier, 1887; Lacaze-Duthiers, 1872), these organs have not been clearly shown to

function in geotactic behavior, for the experimental work which has been done in this respect is open to criticism, having proved difficult to repeat (Pieron, 1928; Crozier and Navez, 1930). On the other hand, a strong case has been made for the existence of a proprioceptive control of snail geotactic behavior. Experiments have shown that snails which normally show negative geotactic movement will change their direction of travel if muscle stress becomes greater on one side of the body than the other. This latter condition can be brought about by attaching a thread to the shell apex and gently twisting the shell out of line with the snail's body. Snails so manipulated turn so that their body lies along the same axis as the shell, and travel in the new direction determined by this axis, even if the new direction is one that is positively geotactic. It has been concluded from experiments of this sort that snails showing negative geotactic behavior have oriented themselves so that there is an equal muscle tension on both sides of the body, as would presumably be true when the shell hangs ventrally. A snail traveling in any direction but upward would presumably experience unequal muscle tension due to the weight of the shell (Crozier and Navez, op. cit.).

While possibly snails may orient to gravity by this method in air or water, orientation of this kind would seem less likely to occur in a medium such as mud. In a mud medium, there is probably very little tendency for a snail's shell to sink faster than its body and so create muscle tension, forcing the body to orient upward. This is almost certainly true when a snail is at rest in a mud medium, and is probably true to a large extent when a snail is moving through the medium, although this remains to be verified. In any case, the results of the present experiment indicate that a re-examination of the possible role of statocysts in snail orientation seems desirable.

The utility of negative geotactic behavior in some species of snails, such as the tree forms, may be that of enabling an animal to regain its normal habitat after accidental dislodgement (Crozier and Navez, op. cit.).

In aquatic pulmonates, negative geotactic behavior may be a mechanism which sends an animal to the surface to gain oxygen (Cheatum, 1934), although other factors may also be

involved, as many pulmonates appear never to surface (Russell-Hunter, 1953). The negative geotactic behavior (if such it should prove to be) described here may have been a response to oxygen loss, the latter perhaps resulting from sudden immersion in the mud medium. Possibly also a medium such as mud will stimulate receptors in all or a part of the snail's body and that negative geotactic movement results from the stimulation. This latter possibility is strengthened by the fact that, while no quantitative records were kept, snails often ceased their upward movement as soon as they had surfaced on the mud, although they still had no direct access to air, being below the surface of the water which was above the mud.

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LOUISIANA LAND SNAILS WITH NEW RECORDS

By DEE SAUNDERS DUNDEE and PATTI WATT[1]
Louisiana State University in New Orleans

Collections made during the past year have revealed three mollusks not previously reported in Louisiana.

Gulella bicolor (Hutton), known previously from this area by Dr. Harold Harry but not reported by him (personal communication, 1959), has been taken from 20 localities in and around New Orleans. Nowhere is it abundant; colonies appear to consist of few individuals which are found only after rains or in very damp habitats.

A small colony of *Praticolella griseola* (Pfeiffer) was discovered in the yard of the Laclede Steel Corporation on France

[1] This paper is an outgrowth of a current investigation supported by a research grant, RG 7194, from the National Institutes of Health, Public Health Service.

Road in New Orleans. We have found it nowhere else even though extensive searches have been made. At this locality it is living in and around a pile of steel girders. The pile shows signs of having been there undisturbed for some time. It is part of a barge which used to make trips to Texas. Possibly this is how this colony came to be here. It is an interesting find in view of Pilsbry's statement (1940, p. 689) concerning *Praticolella* distribution: "The herd of eastern Mexico and Texas is separated from that of the southeastern states by the Mississippi River and State of Louisiana, 300 miles more or less."

Vaginula sp. (?) first came to our attention while collecting in Mobile, Alabama. There it is found in large localized colonies. Up to that time we had not discovered it in Louisiana (probably because of a dry period), but shortly thereafter we began finding it in New Orleans. To date it is known from 4 localities in the city.

Since little is known of the mollusks of Louisiana, we consider it useful at this time to publish a list of the terrestrial mollusks which have been reported.

In this list letters following localities indicate the source of the information as follows: (G) = Goodrich, (Ha) = Haas, (HH) = Harry, (H) = Hubricht, (P) = Pilsbry, (T) = Taylor, (V) = Vanatta, (Vi) = Viosca. Localities are parishes unless otherwise noted.

Helix aspersa (Müller)—Orleans, East Baton Rouge (HH, P, Vi).[2]
H. aperta Born—Orleans (HH, Vi).[2]
Otala vermiculata (Müller)—Orleans. (P)[2]
O. lactea Müller—Orleans (HH).[2]
Polygyra septemvola febigeri (Bland)—Orleans, Vermillion (P); Plaquemines (HH).
P. auriformis (Bland)—Orleans, Calcasieu (P).
P. leporina (Gould)—DeSoto (P); Grant (H); Catahoula (V).
P. triodontoides (Bland)—Calcasieu (P).
P. texasiana (Moricand)—DeSoto (P, HH); Grant, Rapides, Caddo, Orleans, Calcasieu, Nachitoches, Tensas (HH).[3]
P. dorfeuilliana Lea—Nachitoches, DeSoto, Bienville (P); Claiborne (H).

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[2] These were no longer found in 1948 (Harry) and we have found none of them in Orleans Parish.
[3] Specimens may be *P. triodontoides* (Harry, 1951).

Stenotrema labrosum (Bland)—Rapides, Union (P).
S. stenotrema (Pfeiffer)—Madison, Rapides (P).
S. monodon aliciae (Pilsbry)—DeSoto, Bienville, Calcasieu (type locality (P): Evangeline, Allen, Vernon, Rapides (H).
S. monodon form *friersoni* Pilsbry—Catahoula (V).
Mesodon thyroidus (Say)—Morehouse, Franklin, Catahoula (V); Calcasieu, Grant, Ouachita (H).
M. inflectus (Say)—Morehouse, Franklin (V); Calcasieu (H, P); Evangeline, Vernon, Grant, LaSalle (H).
Triodopsis vultuosa (Gould)—Calcasieu (P).
T. cragini Call—Nachitoches (P); Grant, Claiborne (H).
T. caroliniensis (Lea)—DeSoto, Caddo (P).
T. fosteri (F. C. Baker)—Lake Pontchartrain (no parish given) (P).
T. albolabris (Say)—included in the range given by Pilsbry—no definite localities listed (P); Ouachita (H).
T. divesta (Gould)—DeSoto (P).
Haplotrema concavum (Say)—LaSalle (H).
Bulimulus dealbatus (Say)—DeSoto (P).
Rumina decollata (Linnaeus)—Orleans (G, P, Vi); East Baton Rouge (HH).
Lamellaxis gracilis (Hutton)—Orleans (HH, P); East Baton Rouge (HH).
Euglandina rosea (Féussac)—Orleans, Franklin, Iberia, Iberville, W. Carroll (P); Plaquemines (HH).
E. rosea bullata (Gould)—Orleans, St. Landry, Lake Pontchartrain (no parish given), Iberia (P); Franklin (P, V).
Euconulus chersinus (Say)—State of Louisiana (P); Catahoula (V); Plaquemines (HH).
E. chersinus trochulus (Reinhardt)—Caddo (P).
E. chersinus dentatus (Sterki)—Catahoula (V); Rapides (P).
Guppya sterkii (Dall)—Bienville (P).
Retinella indentata (Say)—LaSalle (H); Morehouse, Catahoula (V); Plaquemines (HH).
R. indentata paucilirata (Morelet)—State of Louisiana (P); Claiborne (P, H); Morehouse (V).
Mesomphix friabilis (W. G. Binney)—Morehouse (P, V).
M. vulgatus H. B. Baker—Calcasieu, Iberia, Morehouse, Franklin (P); Vernon, LaSalle (H); Morehouse, Franklin (V).
Hawaiia miniscula (Binney)—included in the range given by Pilsbry—no definite localities given (P); Plaquemines (HH); Morehouse, Catahoula (V).
Ventridens demissus (Binney)—Vernon, Grant, LaSalle (H).
V. demissus brittsi (Pilsbry)—DeSoto, Bienville, Calcasieu (P).
V. intertextus (Binney)—Calcasieu, Claiborne, Evangeline, LaSalle (H); Bienville (P).

Zonitoides arboreus (Say)—State of Louisiana (P); Morehouse, Richland, Ouachita, Franklin, Catahoula (V): Plaquemines (HH).
Limax flavus Linnaeus—Lincoln (T).
Limax marginatus Müller—Caddo (HH).
Deroceras sp.—Plaquemines (HH).
Deroceras laeve Müller—East Baton Rouge, Caddo, DeSoto (HH).
Anguispira alternata (Say)—Catahoula (P, V); Morehouse, Franklin (V).
A. alternata crassa Walker—Caddo, Franklin, Morehouse, DeSoto (P); Claiborne, Ouachita, Grant, Calcasieu, Evangeline, Vernon (H).
Helicodiscus singleyanus (Pilsbry)—Morehouse (P, V); Ouachita (V).
H. singleyanus inermis H. B. Baker—Morehouse, Ouachita (P).
Philomycus carolinianus (Bosc)—Calcasieu, Evangeline, Richland, Ouachita (H).
P. carolinianus flexuolaris Rafinesque—Grant (P).
Pallifera marmorea (Pilsbry)—Vernon, Grant (H).
Oxyloma sallaena (Pfeiffer)—Orleans, DeSoto (P).
Succinea unicolor Tryon—Orleans (type locality) (P).
S. grosvenori Lea—Rapides (P).
S. luteola Gould—Vermillion, Plaquemines (HH).
S. concordialis Gould—Concordia (type locality) (P).
Strobilops texasiana (Pilsbry and Ferriss)—Morehouse, Rapides (P, V).
S. labyrinthica (Say)—Morehouse, Catahoula (V).
S. aenea Pilsbry—State of Louisiana (P); Morehouse, Richland, Catahoula, Franklin; form *micromphala:* Rapides, Morehouse, DeSoto, Richland, Franklin, Catahoula (P).
Gastrocopta contracta climeana (Vanatta)—Orleans, Franklin (V); Morehouse, (P, V); Plaquemines (HH).
G. corticaria (Say)—Rapides (P).
G. pentodon Say—Plaquemines (HH).
G. tappaniana (C. B. Adams)—Morehouse, Franklin (V).
G. rupicola (Say)—included in the range given by Pilsbry—no definite localities given (P); Plaquemines (HH).
G. pellucida hordacella (Pilsbry)—Gulf States (P).
Pupoides albilabris (C. B. Adams)—Gulf States (P).
P. modicus Gould—Plaquemines (HH).
Vertigo milium Gould—Plaquemines (HH).
V. oscariana Sterki—Madison (P).
V. rugosula Sterki—State of Louisiana (P); Morehouse (V).
Helicina orbiculata (Say)—DeSoto, Jefferson, Orleans (P).
Bradybaena similaris—(Ferussac)—Orleans (Ha, HH, G).

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THE AMERICAN MALACOLOGICAL UNION

Twenty-eighth Annual Meeting, June 20-23, 1961

For the third time in its 30 year history, the American Malacological Union convened at the U. S. National Museum in Washington, D. C. Attendance broke all records (150) while the four-day program rolled smoothly along thanks to careful planning and the dedicated services of volunteer members of the National City Shell Club. Behind the scenes was Dr. Harald A. Rehder together with his henchmen Drs. Morrison and Rosewater, all veterans of past A.M.U. meetings, therefore anticipating the requirements of their guests well in advance.

President Thomas E. Pulley presided over the academic sessions; it was due to his vigilance in enforcing time limits that every paper on an unusually full program was heard.

An evening garden party at the beautiful home of Mr. and Mrs. A. Lothrop Lutrell in Rockville, Maryland was the highlight of opening day, and on Thursday the annual dinner was held at the Cumberland Country Club where food, service and sumptuous surroundings left nothing to be desired.

The Executive Council met on Wednesday evening and at the annual business meeting on the following afternoon it was announced that it had been found necessary to raise the annual dues one dollar per year with joint and life memberships to be advanced accordingly. (This advance will not become effective until 1962.)

No site had been selected for the 1962 meeting, but a committee has been appointed to consider the matter and it is ex-

pected that the time and place will be announced in the 1961 report bulletin.

The following slate of officers for the coming year was presented by the nominating committee and elected by unanimous vote of the members present:

President, William K. Emerson.
Vice-president, Albert R. Mead.
2nd Vice-president, Robert W. Talmadge.
Secretary-treasurer, Margaret C. Teskey.
Publications Editor, Morris K. Jacobson.
Councillors-at-Large, John B. Burch, H. B. Herrington, Edward H. Michelson, Virginia Orr.

The field trip on Friday was a 50 mile excursion to Scientists Cliffs on Chesapeake Bay where the clay banks of the Calvert formation yield a seemingly endless series of Miocene fossils. The trek back to the city was the final feature of the 1961 meeting, another to be added to the long list of memorable reunions of the AMU. — Margaret C. Teskey

NOTES AND NEWS

Beckianum—New genus (or subgenus of *Leptinaria* Beck, 1837?) in Achatinidae (Subulininae). Type species is *Synopeas beckianum* (Pfeiffer) H. B. Baker, 1945, Naut. *58*:91; 1947, Naut. *61* (1): plate 1, from Córdoba, Mexico. As stated by Zilch, 1959, Handb. Paläzool. *6* (2):351, *Synopeas* Jousseaume, 1889, is a homonym of Foerster, 1856.

As pointed out in 1945:88, this unique species is very distinct from either *Opeas* (Ferussaciinae) or *Lamellaxis* and *Leptinaria,* sensu stricto (Subulininae) but, from its shell sculpture, it may belong near *Pelatrinia* Pilsbry, 1907 (1):324, which was proposed as a subgenus of *Leptinaria. Pelatrinia* has a larger, more conoid and imperforate shell, which carries its columellar cord into the aperture.—H. Burrington Baker.

Maxwell Smith—Dr. Joshua L. Baily, Jr., writes from Asheville, N. C., that Maxwell died there Sept. 12, and that a biographic sketch will be prepared for a future number.—H.B.B.

Southern California slugs, additional locality records.—The following records are here listed because of their importance in establishing knowledge of distribution.

Lehmannia poirieri (Mabille). Santa Cruz Island, Stanton

Ranch headquarters (introduced), 23-I-1960. Dr. Carey Stanton! Probably all records of *Limax marginatus* Müll. from North America, and certainly all California records of same should be referred to this species[1].

Anadenulus cockerelli (Hemphill). Kern County, south of sawmill at head of Tejon Canyon, Tehachapi Mts., altitude about 5,300 feet, 3-V-1958. W. O. Gregg, W. B. Miller!

Ariolimax columbianus stramineus Hemphill. Ventura County, Santa Paula Canyon, altitude about 2,700 feet, 29-V-1955. Ed Peterson!

Hesperarion niger (J. G. Cooper). Kern County, west of Poso Creek and about one half mile north of Glenville—Woody road, 8-VI-1945. Under oak log in damp meadow. W. O. Gregg, M. L. Walton! This is the record which Dr. Pilsbry[2] refers merely to "northern Kern Co." Tulare County, along Arrastre Creek, about 3 miles east of White River, altitude about 2,200 feet, 26-V-1957. W. O. Gregg, W. B. Miller, W. B. Miller Jr.!

Hesperarion hemphilli (W. G. Binney). Santa Cruz Island, Canada del Puerto, 1.3 mile from Prisoners Harbor, 17-I-1960. Found under old log. W. B. M., W. O. G.! Santa Barbara County, along Salsipuedes Creek near Calif. Hwy. 1, about 3.4 miles south of junction with Hwy, 150, 10-III-1951. W. O. G., W. B. M., W. B. M. Jr.! San Luis Obispo County, near tributary of San Luis Obispo Creek at old ranch road .8 mile north of U. S. Hwy. 101, south side Cuesta Pass, Santa Lucia Mts., 13-II-1960. W. O. G., W. B. M.!

Binneya notabilis J. G. Cooper. Santa Barbara Island, El Primero Canyon, 19-IV-1959. W. O. G., W. B. M.! Shells only, but with epidermis remaining on some shells. Very dry at time of collecting. — Wendell O. Gregg.

Mass movement of a colony of the mud snail *Ilyanassa*.—In a survey of the marine life at Cape Ann, Massachusetts, a dense colony of *Ilyanassa obsoleta* was discovered on a mud flat bordering a salt marsh about midway up Little River in 1933. Little River is a side channel to the Annisquam Tidal River, a marine inlet which divides the Cape Ann Promontory. The habitat was very soft, black, sticky mud. The colony in question occupied an area about 85 feet wide and extended outward from the edge of the salt marsh for some 80 feet downshore. In 1935 a series of quadrat counts gave a range of 25-61 with an average of 43 snails

[1] Quick, H. E., Proc. Mal. Soc. London, vol. 29, pt. 5, pp. 181-189; British Slugs, Bull. British Museum, Zool., vol. 6, no. 3, p. 197-200.

[2] Pilsbry, H. A., Land Mollusca of North America, vol. 2, pt. 2, p. 724.

per quarter square meter. Measurements the next year indicated the same abundance. In 1956, quadrat counts ranged from 7-36 with an average of 21 snails. Counts made the next two years gave a range of 9-53 and an average of 26 in 1957; a range of 8-64 with an average of 26 in 1958. I observed, however, that a band of snails, usually not far from the marsh, had a density of about 3 snails per square inch. This band of maximum density seemed to shift with fluctuations of tidal levels between spring tides and neap tides. The 5 quadrat levels at which the counts were made and are quoted above, never fell on this narrow band of maximum density. In 1960 this colony was first visited on August 6. The water level at the time of observation did not permit an extensive sample, but abundance seemed to be about the same as in the past 4 years. On September 6, however, a single snail was found in the area formerly occupied by the colony described above. A search disclosed that the entire colony had moved to a new area some 150 feet northeastward, to the entrance of a ditch which cuts back into the marsh. No explanation seems apparent for this mass movement. — Ralph W. Dexter, Department of Biology, Kent State University, Kent, Ohio.

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Pages in *italics* include new taxons

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THE NAUTILUS

Vol. 75 January, 1962 No. 3

THE DISTINCTION BETWEEN ACTEOCINA CANDEI AND RETUSA CANALICULATA

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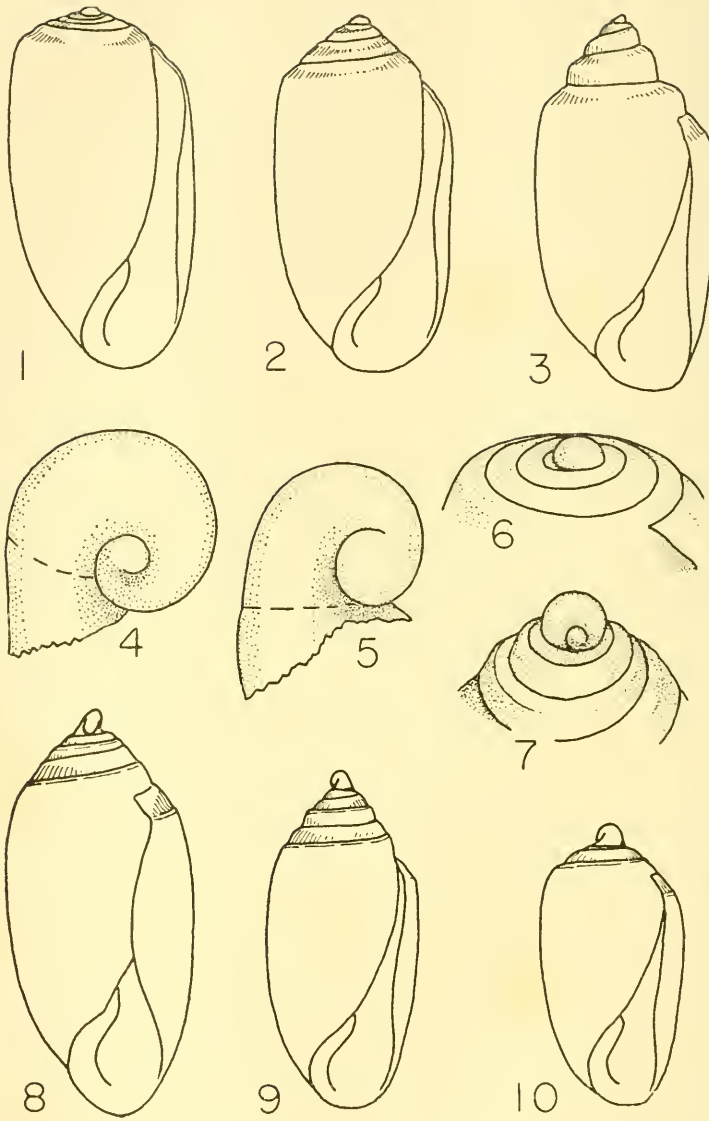
Abbott (1954) has suggested that the opisthobranch gastropods *Acteocina candei* (Orbigny) and *Retusa canaliculata* (Say) may belong to the same species and may be merely geographic races or subspecies. The recovery of a large number of *Acteocina candei* from offshore waters in the vicinity of Cape Hatteras has permitted us to compare this form with an equally large number of superficially similar specimens of *Retusa canaliculata* collected in Pamlico Sound. Our observations and conclusions are presented in this report. Our comparisons led to the discovery of certain aspects of the biology of *Retusa canaliculata* not previously recorded, including the presence of a radula and the occurrence of non-pelagic reproduction in this species.

Material. More than 300 specimens of *Acteocina candei* were recovered from the stomachs of seastars (*Astropecten articulatus*) collected from a sand bottom off Ocracoke Inlet, North Carolina, at a depth of 4 to 7 fathoms (Wells et al 1961). Most of these were fresh specimens, from the soft parts of which radulae could be recovered. A similar number of specimens of *Retusa canaliculata* were collected from sand flats 2 to 3 inches below mean low tide along the eastern shore of Pamlico Sound 1 mile north of Avon, N. C. These two collecting stations are separated by a distance of less than 30 nautical miles. While one habitat is oceanic, the other is estuarine, with a greater range in temperatures, more rapid temperature changes, and reduced salinities.

In addition to these specimens from North Carolina, shells of both species from different parts of their ranges have been examined at the U. S. National Museum.

Observations. These "forms" differ in several consistent characters: *Overall shell shape.* Variations in the shell shape of *Acteocina candei* and *Retusa canaliculata* are shown in Figures 8-10 and 1-3, respectively. Specimens from the oceanic collection (*A.*



Figs. 1-3. *Retusa canaliculata,* showing variation in shell shape. Fig. 3. *R. canaliculata* with extreme development of the spire (protoconch eroded). Fig. 4. *Acteocina candei,* protoconch. Fig. 5. *R. canaliculata,* protoconch. Fig. 6. *R. canaliculata,* apical view. Fig. 7. *A. candei,* apical view. Figs. 8-10. *A. candei,* showing variation in shell shape. (Fig. 10 shows juvenile condition.) (Figures were prepared with aid of a camera lucida.)

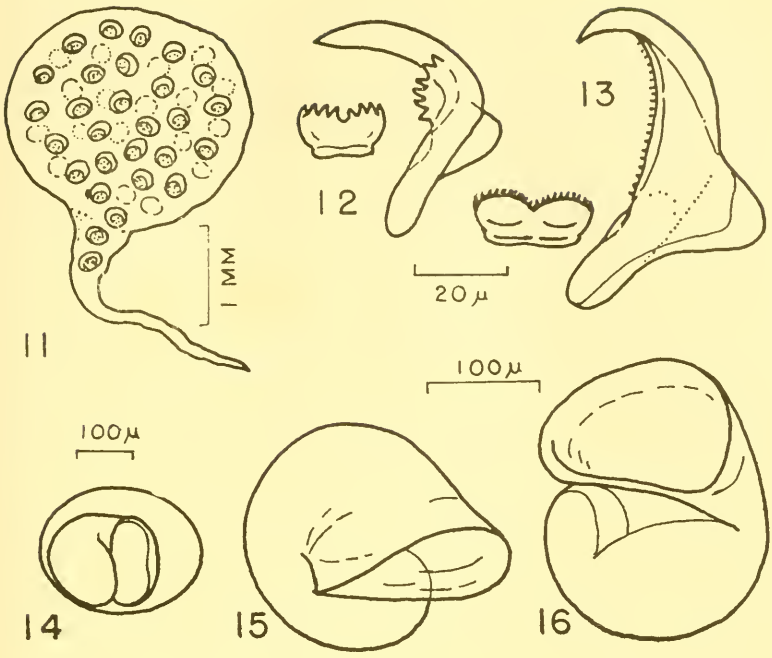


Fig. 11. Egg mass of *Retusa canaliculata*. Fig. 12. Radular teeth of *Acteocina candei*. Fig. 13. Radular teeth of *R. canaliculata*. Fig. 14. *R. canaliculata*, egg membrane containing veliger. Figs. 15-16. Shell of newly hatched *R. canaliculata*. (Figures were prepared with the aid of a camera lucida.)

candei) are generally spindle-shaped, with an elevated spire and a tapered base, so that the shell is widest in the middle (Figs. 8 and 9). However, juvenile specimens of *A. candei* may appear more or less truncate (Fig. 10), because of the lesser development of the spire. The aperture tapers gradually at its apical end. Specimens from the estuarine collection (*R. canaliculata*) are more cylindrical in shape, usually with lower spire, with a more rounded base, and with nearly parallel sides, so that the shell is shouldered and nearly as wide near its apical end as it is in the middle (Figs. 1 and 2). However, there is some variation in the elevation of the spire in *R. canaliculata*, occasionally approaching (as in Fig. 3) the development characteristic of *A. candei*. The existence of individuals with such "intermediate" shell characters has no doubt led to confusion in identification. Specimens of both species that show a broad shallow depression in the middle of the

last whorl (as in Fig. 2), producing a sinuous outer lip such as that figured by Marcus (1958, fig. 26) for *Acteocina* (=*Tornatina*) *candei* have been examined. A similar depression is shown in the shells of *Retusa obtusa* figured by Lemche (1948, figs. 43-53), but in that species also this character is variable and not always present. Because of its occurrence in several similar species and the variability of its expression, such a shallow depression cannot be used as a reliable character for the separation of species.

Protoconch. Whereas in *A. candei* the protoconch is obvious and projecting, in *R. canaliculata* only a small portion is visible as a small protuberance, and this is often eroded. The heterostrophic protoconch of *A. candei* is composed of about one and one-half whorls (Fig. 4) set at an angle of 80° from the axis of the adult shell. It is about ¼ submerged in the first adult whorl (Fig. 7). In contrast, the heterostrophic protoconch of *R. canaliculata* contains only about ¾ of a whorl (Fig. 5) set at an angle of 80° from the adult shell axis. It is about ⅔ hidden by the first adult whorl (Fig. 6). This difference in protoconchs would indicate that the planktonic stage is of moderate length in the larva of *A. candei,* while the planktonic stage is suppressed in the larva of *R. canaliculata.*

Radular teeth. Using the technique described by Turner (1960), the radulae were mounted for examination. The radular teeth of a specimen of *A. candei* 2.5 mm. in length are shown in Figure 12. The median tooth is 18 microns wide, 10 microns high, and bears 4 or 5 forward projecting denticles on each of two arches. The lateral tooth, with an overall length of 45 microns, has a base 33 microns long and a moderately curved cusp 30 microns long; it bears 5 to 7 sharp denticles on an expansion at the angle formed at the base of the cusp. By the same technique, a radula was discovered in *R. canaliculata,* the teeth of which are shown in Figure 13. For a specimen 3 mm. in length, the median tooth is 30 microns wide, 19 microns high, and is comprised of two arches, each bearing ten or eleven denticles. The lateral tooth is approximately 65 microns long, with a base 46 microns long and a strongly curved cusp 41 microns long that bears 16 to 20 small denticles on a curved ridge. For each species, the radulae of at least 10 specimens were examined. The shape of the teeth and the distribution and relative size of the denticles clearly dis-

tinguish the radulae of the two species.

Because of the minute size of the radulae in these species, adequate radular preparations are difficult. Evidently, the radulae of both species escaped detection by early workers. Pilsbry (1893) treated both species as having no radula; however, later workers recognized the presence of a radula in *Acteocina* (Thiele 1931; Marcus 1958, as *Tornatina*). Thiele (1925) could find no radula in *Retusa canaliculata,* and many workers (Marcus 1958, Zilch 1959, and others) have utilized the absence of a radula to characterize the Retusidae, and to place *R. canaliculata* in this family. The possession of a radula is used for the placement of *Acteocina candei* in the Scaphandridae. Since *R. obtusa* (Montagu) is the type species of *Retusa,* the discovery of a radula in *canaliculata* makes a re-examination of *R. obtusa* for the presence of a radula necessary in order to clarify the position of *canaliculata* in opisthobranch classification. Until the presence or absence of a radula in *R. obtusa* is ascertained, we prefer to retain *canaliculata* in the genus *Retusa.*

Although the possession of a slightly modified shell may reflect environmental differences between two habitats occupied by the same species, the differences considered above can scarcely be attributed to the environment. On the basis of this comparison, these forms should be regarded as biologically distinct species. This group of differentiating characters, particularly the differences in protoconchs and radular teeth, provide unquestionable grounds for the recognition of two species.

Acteocina candei occurs from North Carolina south to Argentina (Carcelles & Parodiz 1938), principally in offshore or oceanic habitats. In contrast, *Retusa canaliculata* occurs from Cape Cod to the West Indies, primarily in estuarine habitats. As Parker (1959) noted for the Texas coast, *R. canaliculata* is a characteristic inhabitant of enclosed bays of variable, low to intermediate salinities.

Reproduction in Retusa canaliculata. Egg masses produced by *Retusa canaliculata* (Fig. 11) were collected on sand flats in Pamlico Sound, where they were found to be relatively common from May to October. The egg masses of this species bear a resemblance to one figured by Thorson (1946, fig. 151) as that of *Philine scabra.* They are composed of a spherical jelly mass about

2.0 to 2:5 mm in diameter, attached by a strand about 5 mm long to stems and blades of marine grasses, worm tubes, shell fragments, and other objects. Each mass contained a number of large eggs, each within its own egg membrane (Fig. 14). The enveloping egg membranes are ovoid and 0.30 to 0.35 mm in length. Although eggs were usually found only in the enlarged spherical part of the mass, in some cases they were also contained in the attachment strand, as figured. A number of egg masses were removed to the laboratory for observation. Development progressed within the egg capsule, through a shelled veliger stage, to a miniature crawling juvenile. These young snails were observed crawling within their individual egg capsules, from which they eventually emerged to crawl about the aquarium. These observations constitute the first record of non-pelagic development in *Retusa canaliculata.*

The retention of the veliger stage within the egg capsule undoubtedly serves to maintain this species in estuarine areas where the net flow of water seaward could carry planktonic larvae away from an otherwise favorable environment. The evolution of such a mechanism would have considerable survival value for the larvae of species that inhabit estuaries. Indeed, non-pelagic development insures a more stable population size (Thorson, 1950). Such a non-pelagic development has been demonstrated for some species of echinoderms, polychaete annelids, prosobranch gatropods, and pelecypods (Thorson, 1950). Generally, tectibranchs have been considered to produce planktonic larvae.

Lemche (1948) indicated that studies of the apical whorls of tectibranch gastropods may give reliable evidence about their larval development, and Thorson (1950) successfully applied similar correlations of apical shell form to the development of prosobranch gastropods. According to Lemche's standards, the blunt, relatively coarse protuberance formed by the protoconch of *Retusa canaliculata* fits the general protoconch morphology that is correlated with a reduced or suppressed planktonic development. Significantly, Lemche found the protoconch of *Retusa obtusa* to be wanting, and suggested that it probably exhibits a non-pelagic development. In his survey of Danish planktonic larvae, Thorson (1946) had not found larvae that he could assign to *R. obtusa,* although adults of that species had been known

from the area studied. Evidently, *R. obtusa* shares with *R. canaliculata* a non-pelagic type of reproduction.

The relatively large size of the eggs and the prolonged reproductive period of *R. canaliculata* are features that have been correlated with non-pelagic development in other marine invertebrates (Thorson 1950). By increasing the chances of successful reproduction, these characters contribute to the effectiveness of non-pelagic development as an effective mechanism for the production of a new generation without the waste usually associated with planktonic reproduction.

Acknowledgments. These specimens were obtained and studied during the course of research supported by a grant (G-5838) from the National Science Foundation to Dr. I. E. Gray of Duke University and aided by the Cape Hatteras National Seashore of the National Park Service. The authors wish to express their appreciation to Dr. Harald A. Rehder and Dr. J. P. E. Morrison of the Division of Mollusks, United States National Museum, for making available specimens and literature.

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RANGE EXTENSION FOR CYMATIUM CARIBBAEUM WITH A NOTE ON ADVENTITIOUS DISPERSAL

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Bureau of Commercial Fisheries Biological Laboratory
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A specimen of *Cymatium caribbaeum* Cl. & T. was recently sent to me by Mr. Richard Spencer of Charleston, South Carolina. He had collected the example alive from a navigation buoy after it was brought in from its station off Port Royal, South Carolina, to the U. S. Coast Guard Base at Charleston for cleaning and servicing. Clench and Turner (Monograph of the family Cymatiidae in the western Atlantic. Johnsonia: *3* (36) : 206, 1957.) record the northernmost range for this species as Lake Worth, Florida. The buoy record thus extends the range northward along the Atlantic coast about 350 miles.

The specimen is a thin-lipped juvenile, height 31.7 mm., width 16.1 mm. This is the second species of this genus whose range has been considerably extended northward as a result of buoy sampling. The first was a juvenile *Cymatium labiosum* (Wood) which I collected in 1948 from a buoy brought in from off Cape Romain, South Carolina. This record appears in the monograph by Clench and Turner (1957) on page 202.

The Cymatiidae are stenothermic and range widely in all tropical waters. A probable long larval stage aids in their wide dispersal according to Clench and Turner. The larvae of the *Cymatium* species found on the South Carolina buoys probably chanced to be dispersed northward from Florida by way of rapid transport in the Gulf Stream. Caught in the coastal waters below Cape Hatteras, they finally settled on the convenient buoy surfaces.

The normal longitudinal distribution of a species with pelagic larvae is controlled for the most part by the temperature extremes that it can tolerate as an adult. The chance dispersal beyond the consistent range of such a species is probably common. When this occurs and when the larvae happen to settle in a favorable habitat during a season in which the temperatures are also favorable, the organisms may survive and grow until such time as

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* Wells, W. Harry and I. E. Gray. The seasonal occurrence of *Mytilus edulis* on the Carolina coast as a result of transport around Cape Hatteras. Biol. Bull.: *119* (3) : 550-559, 1960.

the temperature becomes lethal. The fact that an adult of the genus *Cymatium* has never been recorded from the bottom in offshore Carolinian waters suggests that juveniles are winter-killed.

Wells and Gray* recently reported on a cold water species, *Mytilus edulis,* which commonly spreads beyond its normal southern limit at Cape Hatteras. The species is unable to survive summer temperatures in the northern part of the Carolinian subprovince. However, the larvae of the fall spawning colonize this area after the water temperatures fall below lethal values.

There is no need to stress the importance of accurate range records for ecological purposes. In order to increase the accuracy of range records, one must distinguish between that part of the range within which a species is able to maintain itself and propagate, and that portion, usually at the extremes, where it is unable to complete its life history. It is also important to record whether the specimen was alive or dead when collected; especially near the borders of its geographic or bathymetric range. Knowledge of extreme range is particularly useful to indicate possible modifications in the usual biota of an area should long-range environmental changes alter, even slightly, in any direction.

ARCIDENS CONFRAGOSUS AND PROPTERA CAPAX IN KANSAS

By HAROLD D. MURRAY
Department of Zoology, The University of Kansas

The extended ranges of the two species of mussels herein reported are the result of studies of the unionid fauna of Kansas from the years 1956 to 1959. Call (1885, 1886 and 1887) listed numerous species of unionids in Kansas without descriptions or illustrations, and Scammon (1906) described and illustrated the species of fresh-water mussels occurring in Kansas. Neither Call nor Scammon reported these two species as occurring in Kansas. A search of the literature indicates that neither has been recorded for Kansas. Catalogue numbers refer to the mollusk collection of the Museum of Natural History, The University of Kansas, Lawrence, Kansas.

Arcidens confragosus (Say), KUMNH. 11083. This species was not collected by the author but was uncovered, quite by accident, in the museum collection. R. W. Reese obtained a single gravid

specimen of *Arcidens confragosus* from the Marais des Cygnes River, 3 miles east of Ottawa, Franklin County, Kansas, on September 25, 1949. Unfortunately, only a half shell of this specimen remains in the museum collection. An empty shell of *A. confragosus* was found at a later date at the same locality, but has subsequently been lost. The half shell remaining in our collection measures 60 mm. in length and 42 mm. in height. *A. confragosus* was taken from a gravel shoal where the water ranged in depth from one to five feet. Subsequent attempts to collect additional examples have been unsuccessful.

Because Utterback (1916:103) reported *A. confragosus* as occurring in northern and central Missouri and because the Osage River (Marais des Cygnes River in Kansas) flows through central Missouri, the presence of *A. confragosus* in Kansas is not surprising. Possibly *A. confragosus* may occur in isolated areas in eastern Kansas not yet adequately sampled.

Proptera capax (Green), KUMNH. 10486. A gravid specimen of *Proptera capax* was recovered by the author on August 27, 1956 from the Neosho River, 7½ miles east and 1 mile south of Emporia, Lyon County, Kansas. Simpson (1914:47) reported the westernmost range of *P. capax* as the St. Frances River in eastern Arkansas and two almost certainly invalid records from the Elkhorn and Blue Rivers, Nebraska.

Inasmuch as the St. Frances River in Arkansas empties into the Mississippi River a short distance from the Arkansas River and inasmuch as the Neosho River is a tributary of the Arkansas River, it is not surprising that *P. capax* should occur in the Neosho River in Kansas. Although Utterback (1916:163) reported *P. capax* in Missouri, his records, as best as can be determined, are from the extreme eastern portion of Missouri. *P. capax* has not been reported to this date in those streams flowing from Kansas through Missouri to the Mississippi River, which is somewhat surprising considering the appearance of *P. capax* in the Neosho River.

The single example of *P. capax* thus far known for Kansas is typical in most respects for the species. The nacre is a somewhat darker purple, and the shell is somewhat more elongate than specimens from the Mississippi River.

The Kansas specimen measures 155 mm. in length and 101 mm.

in height. In length, this specimen exceeds the previously reported maximum length of *P. capax* by 12 mm. (Haas, 1941:261). *P. capax* was recovered from slowly moving water 3½ feet deep in a substrate of small rocks and sand having very little silt.

Because *A. confragosus* is a species with unusual morphological features and not likely to be confused with other species, and because Call (1885, 1886 and 1887) and Scammon (1906) did not report this species in Kansas, it seems most likely that *A. confragosus* has made its appearance in Kansas after 1906. It is my opinion that *P. capax* may have occurred sparsely in Kansas for many years and may possibly have been confused by Call and by Scammon with *Lampsilis ovata ventricosa* (Barnes).

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RADULAE OF NORTH AMERICAN ANCYLID SNAILS I. SUBFAMILY RHODACMEINAE [1]

By PAUL F. BASCH
Department of Biology, Kansas State Teachers College, Emporia

freshwater limpet snails, constituting a distinct subfamily of the family Ancylidae, and limited in distribution to the southeastern United States. Walker (1917) recognized two "sections" or subgenera of *Rhodacmea* based partly upon conchological characters, but principally upon features of the radula, to be discussed below. In connection with a continuing study of North American freshwater limpets, I have reported briefly on the anatomy of one species of *Rhodacmea* (Basch, 1960), and more recently have examined the radulae of other species in an attempt to understand better this unusual genus of mollusks. I am indebted to Dr. Henry

[1] Supported by grant G-14125 from the National Science Foundation.

The genus *Rhodacmea* consists of about half a dozen species of

van der Schalie of the University of Michigan Museum of Zoology (UMMZ) for kindly making available to me the material used in this study.

The radulae upon which Walker based his systematic conclusions were prepared for him by Rev. H. M. Gwatkin of Cambridge, England. The specimens from which those slides were made were collected in the Tennessee and Coosa River drainages in Alabama, presumably by A. A. Hinkley or H. H. Smith, in the first decade of this century. In Walker's 1917 paper, and again the following year (Walker, 1918), two figures illustrate the radulae of *Rhodacmea filosa* (Conrad) and *R. rhodacme* Walker. These drawings were the work of Mrs. Lydia M. H. Green. Although probably Mr. Walker examined the preparations himself, there is to my knowledge no direct evidence that he did so.

I have examined 7 slides of radulae prepared by Rev. Gwatkin, including those from which Mrs. Green made her original illustrations. The fact that his preparations have remained in excellent condition for over half a century is a tribute to the skill of Rev. Gwatkin, who died in November, 1916. In addition, I have prepared 24 slides of radulae extracted from dried animals found within their shells in the UMMZ collection. The wide open aperture of the limpets and the lack of spiral coiling allowed easy removal of the dry animals without damage to the shells. After removal, the animals were soaked for several hours in a 0.5% solution of trisodium phosphate to soften the tissues, and the radulae then dissected out. Although large portions of these frail ribbons could be removed intact, I could not obtain an unbroken radula in this manner. The number of transverse rows of teeth per ribbon could therefore not be determined. In some cases, where bits of tissue adhered to the radula, the entire piece of ribbon was immersed briefly in a dilute solution of sodium hypochlorite (clorox) to clean it. Such treatment does not harm the teeth if performed judiciously, and is far more convenient than the traditional sodium hydroxide bath. All ribbons were rinsed in 70% ethyl alcohol and mounted in polyvinyl lactophenol, a mounting medium which dries fairly rapidly and does not require previous dehydration and clearing of the specimen.

The following specimens were examined, all UMMZ numbers:
A. Prepared radulae from the Gwatkin collection

#946, 947, 948 — *R. rhodacme* Walker, Coosa River.
#949 — *R. gwatkiniana* Walker, Coosa River.
#950, 951 — *R. elatior* (Anthony), Tennessee drainage, Florence, Alabama.
#976 — *R. filosa* (Conrad), Coosa River

B. Radulae extracted and mounted from dry specimens
#65998 — *R. cahawbensis* Walker, Little Cahaba River, Bibb County, Alabama. 2 specimens.
#69213 — *R. filosa,* Coosa River, Talladega County, Alabama. 8 specimens.
#69221 — *R. gwatkiniana,* Coosa River, Coosa County, Alabama. 3 specimens.
#69223 — *R. gwatkiniana,* Coosa River, Chilton County, Alabama. 4 specimens.
#69237 — *R. rhodacme,* Coosa River, St. Clair County, Alabama. 7 specimens.

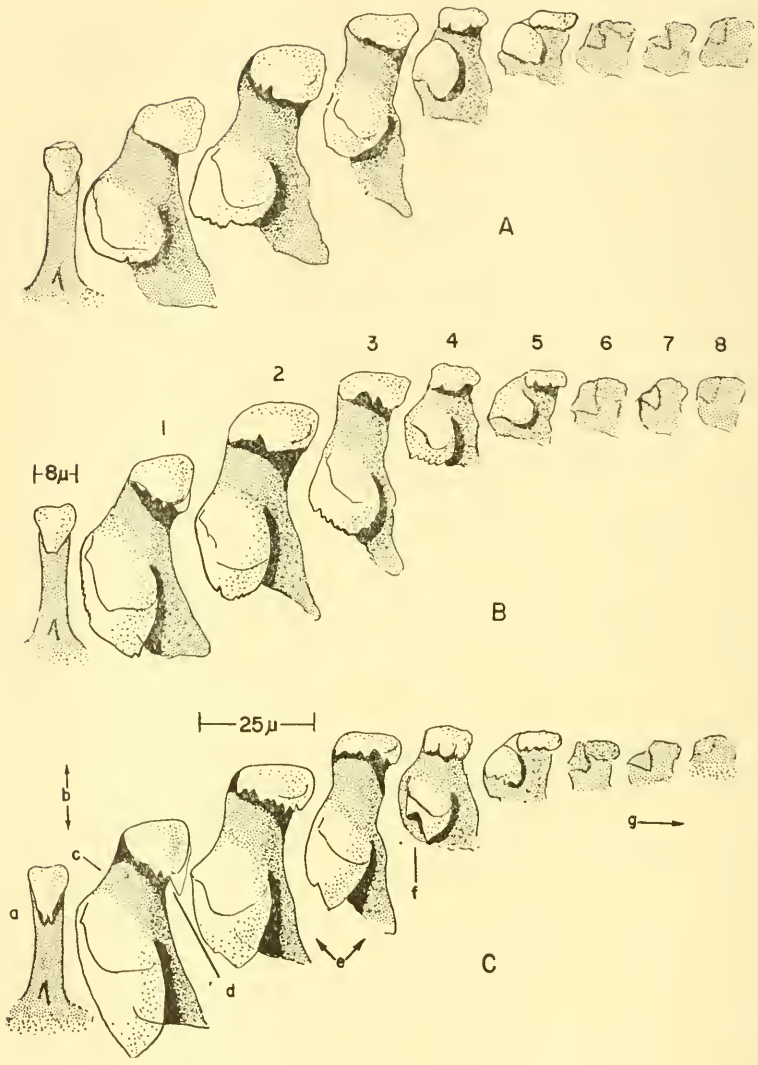
All the identifications of species are those of Walker. A sixth species, *Rhodacmea hinkleyi* (Walker) was unavailable.

The specific features utilized in establishing the two subgenera of *Rhodacmea* are as follows (Walker, 1917):

"Section *Rhodacmea,* s.s. Shell elevated. Radula with a unicuspid central, which has the base triangularly expanded; laterals with the cusp of the mesocone extending but little beyond the base and not overlapping the base of the central tooth." Included in this section were *R. filosa, R. cahawbensis, R. elatior,* and *R. hinkleyi.*

"Section *Rhodocephala,* n. sect. Shell depressed. Radula with a faintly bicuspid central which has the sides of the base straight and not expanded; laterals with the cusp of the mesocone extending far beyond the base and overlapping the base of the central tooth." In this section were placed *R. rhodacme* and *R. gwatkiniana.*

From my study of these species I have come to the conclusion that there is no constant character by which it is possible to distinguish species or species groupings within *Rhodacmea.* I submit that the characters utilized by Walker are largely artifacts, which are based upon two conditions — the amount of wear on the teeth examined, and variations in techniques of mounting the ribbon for study. In figs. A to C are shown 3 rows of teeth from a single radula of *R. cahawbensis.* Changes in the conformation of individual teeth as a consequence of the amount of wear may be easily seen. The central tooth, originally bicuspid, becomes worn down to a single cusp; the length of the mesocone may vary by 30%



Representative teeth from one radula of *Rhodacmea cahawbensis*, UMMZ. #65998, prepared and mounted January, 1961, from a dried specimen. A, teeth near the front of ribbon, showing severe wear; B, teeth from an intermediate area, showing some wear; C, unworn teeth from a region near end of radular sac. Only central and 8 of the 11 teeth on one side are shown. Features marked by small letters in C illustrate variable characters: a, central tooth bicuspid or unicuspid; b, degree of overlapping between rows; c, amount of "shouldering" on medial surface of first tooth; d, configuration of finer denticles on first

within the same ribbon, and the amount to which it overlaps the base and the base of the central tooth are both dependent partly upon wear and partly upon the amount of pressure applied to the coverslip in making the slide. Depending upon the manipulation of the preparation, teeth may be rotated into various positions, and may be separated from each other to a greater or lesser degree. The specific areas of greatest apparent variation in the sample studied are pointed out on figure C.

Previous studies on the reliability of the radula as a taxonomic tool (Howe, 1930; Van Cleave and Richey, 1936) suggest that this structure alone is not a dependable criterion of specific differences within a genus (in those cases, *Viviparus*). In the present genus, although the radula is of the greatest importance in separating *Rhodacmea*, sensu lato from other patelliform fresh-water mollusks, I feel that no reliance can be placed upon it in making critical taxonomic decisions within the genus.

With regard to the elevated versus depressed shell, this may be a character useful for species differentiation, but I do not believe it to be of sufficient importance to separate subgenera, particularly when the radulae are indistinguishable in all species studied. I must conclude that the subgenera (or sections) *Rhodacmea*, s.s. and *Rhodocephala* are based largely upon artifact rather than biological differences, and therefore invalid. In a later paper I hope to discuss the relationships of *Rhodacmea* within the Ancylidae, and of the various species to one another.

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row of teeth; e, lateral distance between teeth, and basal characters; f, pronounced notch present or absent on 4th tooth; g, number of teeth per row (10, 11, or 12, with 1 ribbon of 13). All figures drawn with the aid of a camera lucida.

NEW SPECIES OF HELICODISCUS FROM THE EASTERN UNITED STATES

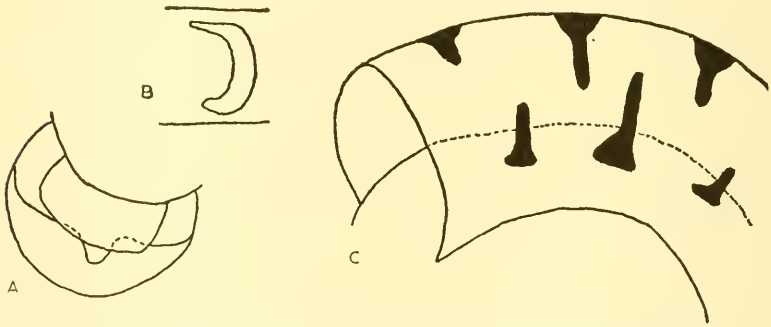
By LESLIE HUBRICHT

HELICODISCUS MULTIDENS, new species. Plate 7, D-F; Text fig. 1

Shell discoidal, spire flat or nearly so; whorls 4½ to 5; pale greenish-yellow, dull, opaque. Umbilicus wide and shallow, showing all the whorls, occupying from 45 to 50% of the diameter of the shell. Whorls well rounded, slowly increasing, the last slowly descending; sculptured with numerous, fine, spiral threads. Aperture lunate, the peristome somewhat thickened within. Within the last quarter whorl there are 3 pairs of teeth on the outer and basal walls. These teeth are radially elongate, raised on a heavy callous ridge, and separated by a rounded sinus. Alternating with these are 3 teeth on the parietal wall. These teeth extend out to about the center of the whorl, are about twice as broad as high, the ends are turned forward, the upper end more so than the lower. Of the 3 sets of teeth the center set is usually more fully developed than the others. As the shell grows, the teeth farthest within are absorbed and a new set added near the aperture.

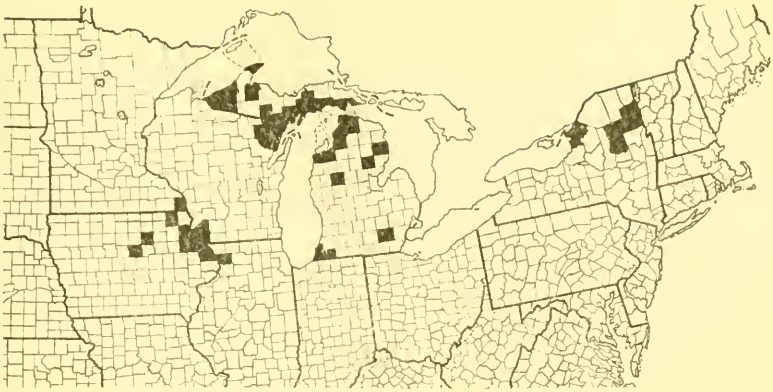
Height, 1.88 mm. Diameter, 4.75 mm. Umbilicus diameter, 2.22 mm. Aperture height, 1.55 mm. 4.5 whorls. Holotype.

Distribution: — *Tennessee:* Putnam Co.: in Jared Hollow Cave, 3 miles northeast of Chestnut Mound (Thomas C. Barr, Jr., coll.). DeKalb Co.; in Jim Cave, 1.5 miles southeast of Dowelltown, holotype 207798 U.M.M.Z., paratypes 17063, collection of the author; in Avant Cave, 1 mile east of Dowelltown.



Helicodiscus multidens Hubricht; A, view of central pair of teeth. B, parietal tooth from above. C, diagram of tooth arrangement.

Helicodiscus multidens is most closely related to *H. triodus* Hubricht. In *H. triodus* the teeth are smaller, and the sets of 3 teeth are placed at irregular intervals in the last whorl, not crowded near the aperture. *H. multidens* is a rare snail, found



Map 1. Distribution of *Helicodiscus shimeki* Hubricht as represented by specimens in the collection of the author and in the collection of the University of Michigan.

only in caves. Of the nine specimens so far collected only one was found alive.

HELICODISCUS SHIMEKI, new species. Plate 7, A-C; Map 1.

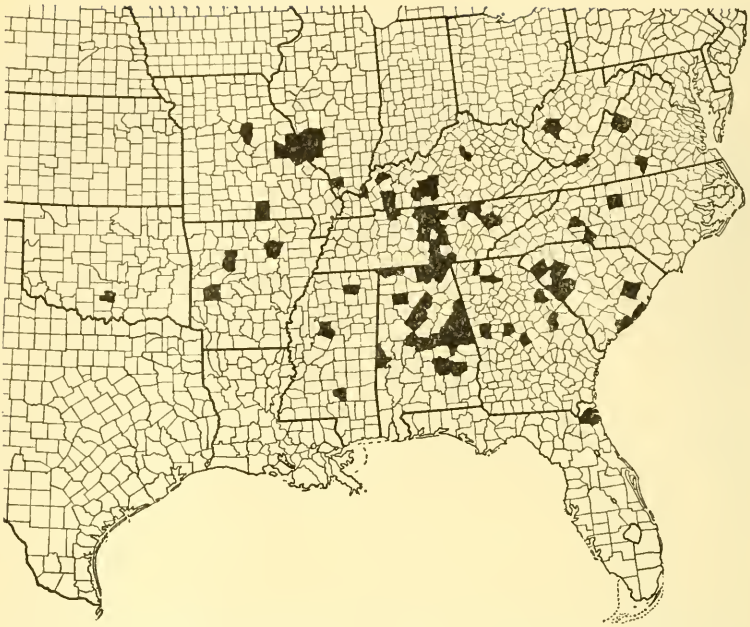
Shell discoidal, pale yellow, somewhat shining, translucent, spire flat or slightly convex. Umbilicus wide, shallow, showing all the whorls, occupying about 50% of the diameter of the shell. Whorls 5 to 6, well rounded, very narrow and slowly increasing; nuclear whorls with faint spiral striae; later whorls with numerous spiral threads. Aperture lunate, peristome thin. Within the last whorl there are usually three pairs of small conical teeth; on the outer and basal walls, the earlier teeth are absorbed.

Height, 1.7 mm. Diameter, 4.2 mm. Umbilicus diameter, 2.1 mm. Aperture height, 1.7 mm. 5.2 whorls. Holotype.

Type locality: Iowa: Delaware Co.: Backbone State Park, holotype 207796 and paratypes 207797 U.M.M.Z., other paratypes 13807, collection of the author.

Helicodiscus shimeki is a species of the northern United States and probably southern Canada, although the author has seen no specimens from there. It ranges from Iowa eastward to northern New York. Map no. 1.

Helicodiscus shimeki may be readily distinguished from *H. parallelus* (Say) by its more slender whorls and its broader, shallower umbilicus. It resembles *H. salmonaceus* W. G. Binney in its proportions, but the thread striae are coarser, and the umbilicus is not quite so broad. It stands somewhat intermediate between these two species. It is named in honor of the late Bohumel Shimek of Iowa City, Iowa.



Map 2. Distribution of *Helicodiscus notius* Hubricht as represented by specimens in the collection of the author.

HELICODISCUS NOTIUS, new species. Plate 9, N-P; Map 2.

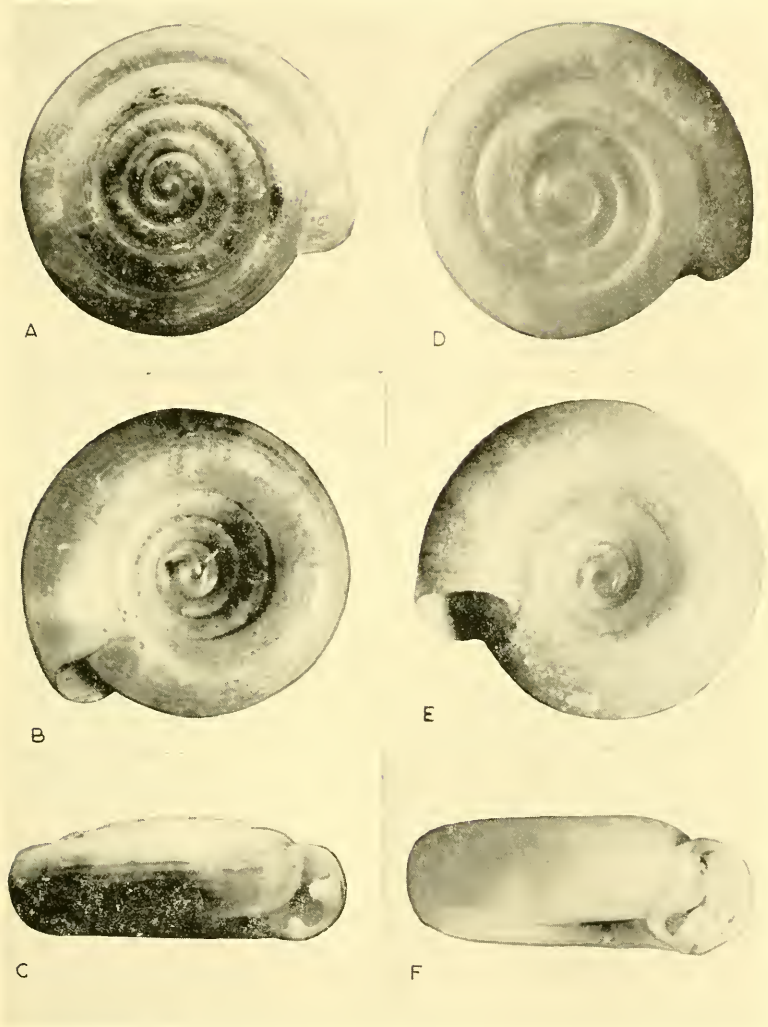
Shell discoidal, the spire flat or nearly so; whorls 5 to 5½; pale yellowish, dull, translucent when young, becoming opaque with age. Umbilicus wide and shallow, showing all the whorls, occupying from 40 to 45% of the diameter of the shell. Whorls well rounded, slowly increasing, sutures well impressed; sculptured with numerous spiral threads. Aperture lunate, peristome thin. Within the last whorl there are usually 2 or 3 pairs of conical teeth, one on the basal wall and one above it on the outer wall.

Height, 1.66 mm. Diameter, 3.66 mm. Umbilicus diameter, 1.62 mm. Aperture height, 1.04 mm. 5 whorls. Holotype.

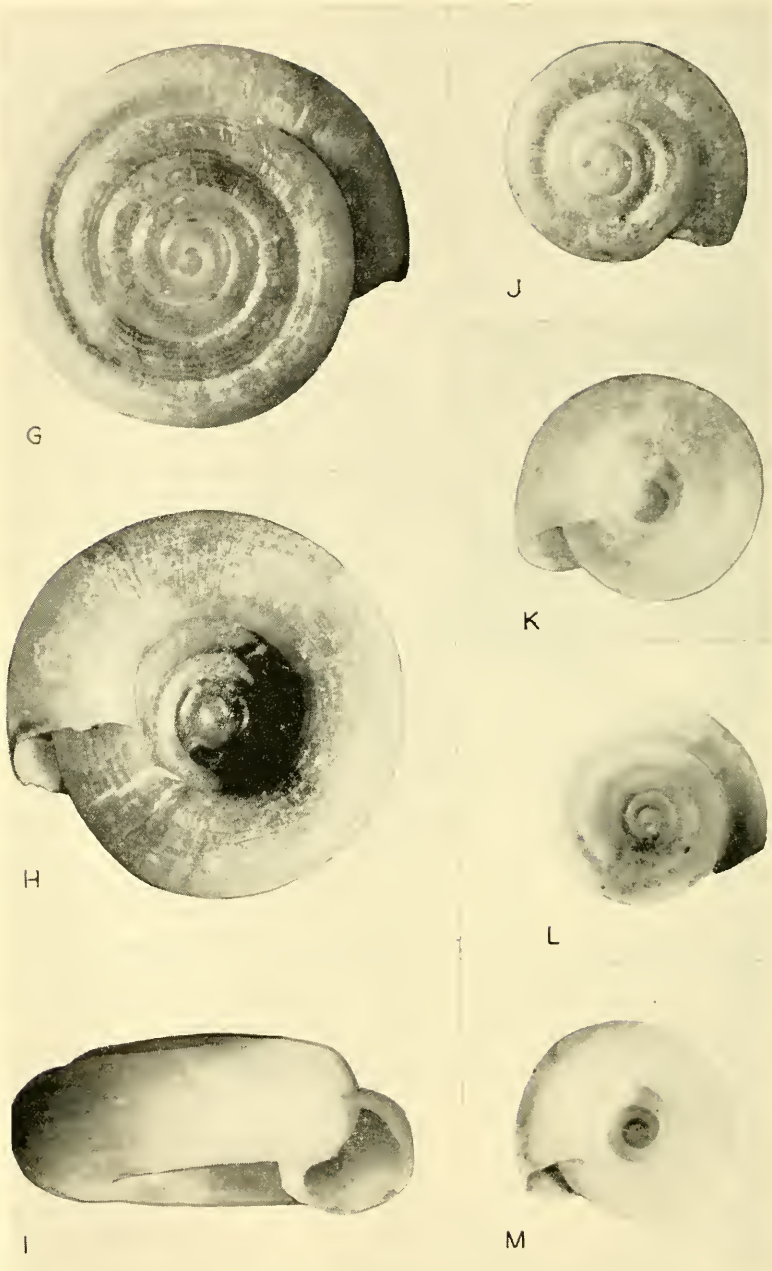
Type locality: Alabama: Jackson Co.: side of Keel Mtn., Paint Rock, holotype 207792 and paratypes 207793 U.M.M.Z., other paratypes 17588, collection of the author.

Helicodiscus notius is found over most of the southeastern United States, ranging from the Gulf north to Virginia and west to Missouri and Oklahoma. See map no. 2.

Helicodiscus notius differs from *H. parallelus* (Say) in being a little larger due to the additional whorl; in having a broader, shallower umbilicus; and in having the thread striae on the embry-



Holotypes. A-C, *Helicodiscus shimeki* Hubricht. D-F, *H. multidens* Hubricht.



Holotypes. G-I, *Helicodiscus notius specus* Hubricht. J & K, *H. hadenoecus* Hubricht. L & M, *H. jacksoni* Hubricht.

onic whorls more strongly developed. It is most closely related to *H. eigenmanni* Pilsbry, from which it differs in being smaller and in having a larger umbilicus.

HELICODISCUS NOTIUS SPECUS, new subspecies. Plate 8, G-1.

Differing from the typical form in being without the internal teeth in shells larger than two and one-half whorls. The last half whorl slowly descends to the aperture, and the peristome is often much thickened.

Type locality: Kentucky: Barren Co.: in Burnette Cave, 0.6 mile west of Park City, holotype 207794 and paratypes 207795 U.M.M.Z., other paratypes 17027, collection of the author.

Helicodiscus notius specus is known only from the type locality. In this cave, it was feeding on the guano of the cave-cricket, *Hadenoecus subterraneus* (Scudder), in company with *Carychium stygium Call.* Typical *H. notius* is occasionally found in caves also, but only where leaves have been washed or blown in. It never has become a guano feeder.

HELICODISCUS SALUDENSIS (Morrison)

Gastrodonta (Clappiella) saludensis Morrison, 1937, Proc. Biol. Soc. Wash. 50-58, Pl. 4, figs. 1-4.

Clappiella saludensis (Morrison), Pilsbry, Land Moll. N. Amer. II, p. 433, fig. 233.

I believe that this species should be placed in the genus *Helicodiscus.* It is so like *H. parallelus* (Say) in its general appearance that one needs a lens to distinguish it. *H. fimbriatus* Wetherby has a similar pattern of internal teeth, although they are not as regularly alternating.

TROGLODISCUS, new subgenus.

Shell with numerous, fine, revolving, epidermal fringes; but without the revolving ridges of *Helicodiscus* s.s. There are no internal teeth at any stage of growth.

Type species: *Helicodiscus barri.*

HELICODISCUS BARRI, new species. Plate 9, R-T.

Shell small, pale greenish-yellow, subtranslucent, thin, depressed; spire low, convex; whorls 4 to 4½, well rounded, sutures well impressed. Umbilicus moderately large and deep, contained about 3 times in the diameter of the shell. Sculpture of numerous, fine, revolving epidermal fringes. There being from 40 to 50 of these fringes on the last whorl. Aperture lunate, peristome thin. There are no internal teeth at any stage of growth.

Height, 1.8 mm. Diameter, 3.9 mm. Umbilicus diameter, 1.4 mm. Aperture height, 1.3 mm. 4.5 whorls. Holotype.

Distribution: *Tennessee:* Dickson Co.: in Columbia Caverns, 2 miles southwest of Van Leer, holotype 207799 and paratypes

207800 U.M.M.Z., other paratypes 17446, collection of the author. Davidson Co.: in Bull Run Cave, 2.5 miles northwest of Scottsboro.

Helicodiscus barri is known only from the total darkness of caves. It was found feeding on raccoon dung. It is named for its discoverer, Thomas C. Barr, Jr.

HELICODISCUS HADENOECUS, new species. Plate 8, J-K; Pl. 9, U.

Shell very small, yellowish, opaque, subdiscoidal; whorls 4, well rounded, sutures well impressed. Umbilicus moderately large and deep, contained from 2½ to 3 times in the diameter of the shell. Embryonic whorl smooth, later whorls, with fine, revolving, epidermal fringes, which are found on both the upper and lower surfaces and in the umbilicus. There are from 30 to 40 of these fringes on the last whorl. Aperture lunate, peristome sinuous, not thickened. There are no internal teeth at any stage of growth.

Height, 1.2 mm. Diameter, 2.7 mm. Umbilicus diameter, 1 mm. Aperture height, 1 mm. 4 whorls. Holotype.

Distribution: Kentucky: Barren Co.: in Beckton Cave, 0.5 mile northwest of Beckton. *Tennessee:* DeKalb Co.: in Avant Cave, 2 miles east of Dowelltown. Van Buren Co.: in McElroy Cave, 1.5 miles northeast of Bone Cave P. O., holotype 207801 and paratypes 207802 U.M.M.Z., other paratypes 17444, collection of the author. White Co.: in Indian Cave, 2.5 miles southeast of Quebeck. Jackson Co.: in Hargis Cave, 1 mile north of Granville (Thomas C. Barr, Jr., coll.) *Alabama:* Madison Co.: in Aladdin Cave, 7 miles northeast of Maysville.

Helicodiscus hadenoecus is known only from the total darkness of caves. It feeds on the guano of the cave-cricket, *Hadenoecus subterraneus* (Scudder). It is related to *Helicodiscus barri,* differing in its smaller size. Dead shells from which the epidermis has been removed show no sculpture other than weak growth lines. They show no ridges like those in *H. parallelus.* Dead shells resemble those of *Hawaiia minuscula* (Binney).

HELICODISCUS PUNCTATELLUS Morrison.

The type locality for this species is *in,* not near, Whites Cave, near Mammoth Cave. The author found dead shells fairly common in Whites Cave, but no living specimens. The author visited nearly every accessible cave in Mammoth Cave National Park without finding this species in any other cave. It apparently occurred only in Whites Cave and is now extinct.

HELICODISCUS JACKSONI, new species. Plate 8, L-M; Pl. 9, Q.

Shell very small, depressed, thin; whorls 4 to 4½, well rounded,

sutures well impressed, spire low but convex. Umbilicus wide, occupying about 40% of the diameter of the shell. Embryonic whorl smooth, later whorls with irregularly spaced growth wrinkles, lower surface of last whorl nearly smooth. Aperture lunate, peristome simple.

Height, 1.11 mm. Diameter, 2.44 mm. Umbilicus diameter, 0.96 mm. Aperture height, 0.77 mm. 4.5 whorls. Holotype.

Type locality: Maryland: Dorchester Co.: subfossil, in shell mound near beach, 0.5 mile west of Elliott, holotype 207803 and paratypes 207804 U.M.M.Z., other paratypes 22476, collection of the author.

Helicodiscus jacksoni is most closely related to *Helicodiscus singleyanus inermis* H. B. Baker, with which it was found. It differs in its distinctly larger umbilicus and in the more prominent growth wrinkles on the upper surface of the last whorl. The whorls are a little more slender and not so tightly coiled. The aperture is smaller. Only dead shells were found, and most of these were chalk white. Some were fresh, these were translucent, with a very pale yellow shell.

It is named in honor of Ralph W. Jackson, who discovered this interesting shell locality.

Paravitrea roundyi Morrison.

Pilsbryna tridens Morrison.

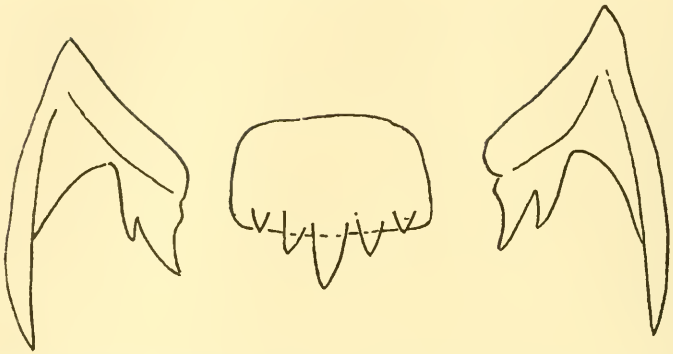
These two species seem out of place in the genera to which they have been assigned. Possibly when they are better known, they will prove to belong to the genus *Helicodiscus*.

TYPE OF THE GENUS ENGINA (BUCCINIDAE)

By VIRGINIA ORR

The type species of the genus *Engina* Gray, 1839, is *Engina zonata* Gray, 1839, by subsequent designation (Gray, 1847). This species has not been correctly identified by authors because it was not figured; the color pattern is uncommon for the species but principally because, in error, Gray described it as 1½ inches long (misprint?).

Mr. S. P. Dance, of the British Museum, recently showed me a lot of two shells, BV. 113, marked *Enzina* (sic) *zonata* Gray in Gray's handwriting. They came from Mr. Guilding and the locality was "West Indies". Neither the adult nor the juvenile shell shows white knobs around the base, the common color-form



Radula of *Engina turbinella* (Kiener), ANSP. 195841, Buccoo Reef, Tobago Island, B. W. I. app. 970×.

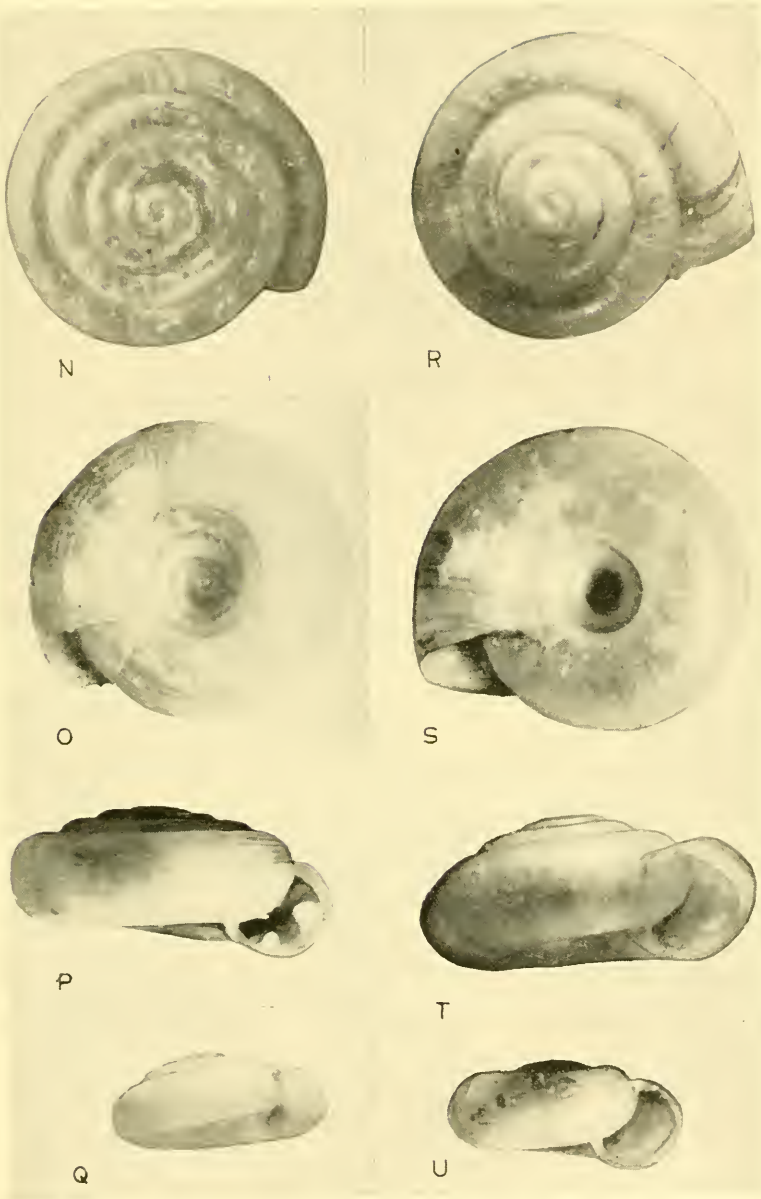
of the species, but both are easily identified as the common western Atlantic species, *Engina turbinella* (Kiener, 1836). The adult shell measures 11.5 mm. in length (approximately ½ inch) and is here designated lectotype of *Engina zonata* Gray. I figure it (Plate 10, fig. A) with a similarly colored specimen from St. Thomas, Virgin Islands, ANSP 34755 (fig. B).

The lot from which the lectotype is taken is the one referred to by Tomlin (1928) as "a possible type lot" and misidentified as *Engina leucozona* (Philippi, 1844). My figure A is from the photograph published by Bartsch (1931). However, I have included a scale showing in the original photograph but not previously published because it explains why Bartsch did not recognize the species.

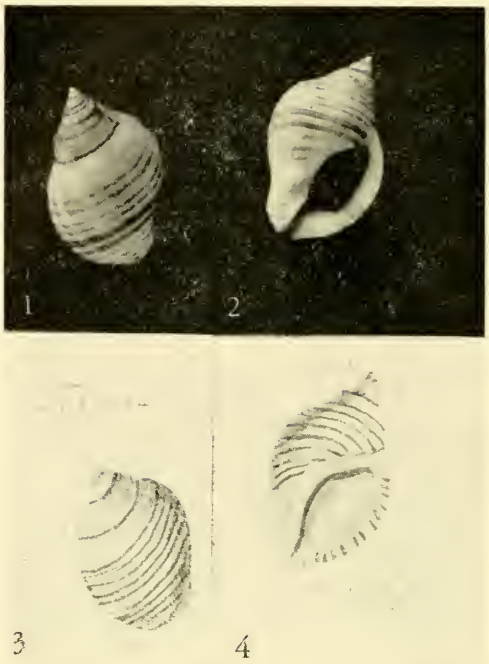
Bartsch saw only the photograph of the specimen and had no notes on the size of the shell except the scale photographed with it. Reading, "Axis: 1½ inches" in Gray's description he presumed the scale was an inch rule and translated the size to 27 mm. He made no attempt to identify this outsized *Engina*.

Although, from the misspelling of the generic name noted earlier, this lot of *Engina zonata* evidently was not labeled by Gray in 1839 (he misspelled *Enzina* in 1842 and 1847), it probably was in his hands when he designated the type of the genus. It is also the only Gray material of that name which has come to light. Except for the discrepancy in size, the specimens agree well with Gray's description.

Fortunately, the better-known name for the species, *Engina*



Holotypes. N-P, *Helicodiscus notius* Hubricht. Q, *H. jacksoni* Hubricht. R-T, *H. barri* Hubricht. U, *H. hadenoecus* Hubricht. Photographs by John B. Burch, University of Michigan.



Nucella lapillus: Figs. 1-2, specimen from France (U.S.N.M. Cat. No. 42636). Figs. 3-4, original figures in Martini, 1780, pl. 124, figs. 1113, 1114. (All figures approximately natural size.)

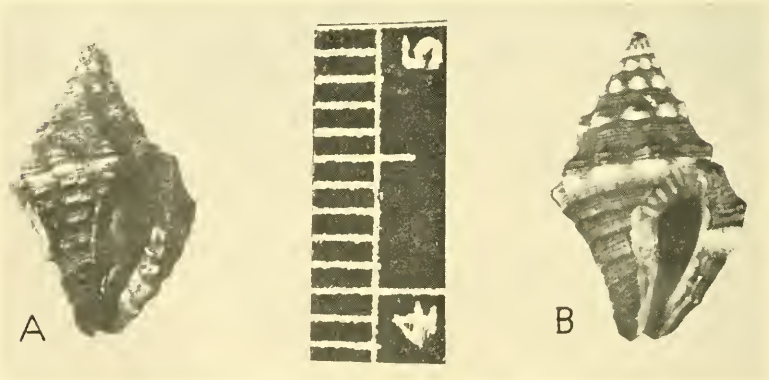


Fig. A. Lectotype of *Engina zonata* Gray, BV. 113, British Museum, West Indies. Scale in mm. Fig. B. *Engina turbinella* (Kiener), ANSP. 34755, St. Thomas, Virgin Islands.

turbinella (Kiener) precedes *E. zonata* by 3 years. Therefore, the type species of the genus *Engina* Gray is *Engina zonata* Gray, 1839 (non Reeve 1846) = *Purpura turbinella* Kiener, 1836.

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THE STATUS OF NUCELLA ROEDING

By HARALD A. REHDER

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The genus *Nucella* was instituted by Röding (Musuem Boltenianum, 1798, p. 130-131) for the 5 species listed below. Following each name I have given what I believe to be the present correct or proper assignment of the species in question:

reticulata	*Cancellaria reticulata* (Linnaeus).
moschatellina	Species dubia.
macina	Nomen nudum.
lapillus	*Paralagena smaragdula* (Linnaeus)
theobroma	*Nucella lapillus* (Linnaeus).

It will be noted that I have been unable to identify one of the species: *N. moschatellina.* Röding rechristened with this name Gmelin's *Buccinum laeve,* repeating the latter's reference to Martini's figures in volume 4 of the Conchylien-Cabinet (1780, pl. 124, fig. 1150). Martini's description of this species in the accompanying text (Conchylien-Cabinet, vol. 4, 1780, pp. 36-37) does not quite agree with the figures, and later authors have been unable satisfactorily to identify the species. Gray (Zoology Beechey's Voyage, 1839, p. 126) placed it in his new genus *Bullia* and gave as a synonym *squalida* King. However, the finely striated sculpture and grooved interior of the aperture mentioned by Martini speak against this assignment. The same criticism can be leveled against Pfeiffer's (Krit. Register Martini & Chemnitz Konch.—Kat., 1840, p. 33) suggestion that the species may represent the juvenile stage of *Buccinum undatum* Linnaeus.

Clench, in his treatment of the western Atlantic species of *Purpura* and *Thais* (Johnsonia, vol. *2,* no. 23, 1947), has discussed on pages 85-86 the problem of the type of *Nucella,* but

because I have come to a conclusion differing from his I am placing my views on record, as I feel that the nomenclature of this common boreal group should be settled.

Nucella was first actively revived by Dall in 1909 (Prof. Paper U. S. Geol. Survey, no. 59, 1909, pp. 46-48, 50) as a subgenus of *Thais* Röding. Clench (l.c.) is correct in stating that Dall did not specifically designate a type, although he undoubtedly intended to do so in his outline of the classification on page 50, where he cites *T. [hais] lapillus* after the name *Nucella* s.s. Later on, in his paper on the members of this group from northwestern America (Proc. U. S. Nat. Mus. *49,* no. 2124, 1915, p. 558) he did definitely designate *N. lapillus* (Linnaeus) as type. As Clench has pointed out, this is an invalid designation since Linnaeus' species was not included by Röding in his genus. Therefore, Suter (Manual of New Zealand Mollusks, 1913, p. 425), Iredale (Trans. Proc. New Zealand Inst. *47,* 1915, p. 472), and Grant and Gale (Mem. San Diego Soc. Nat. Hist. *1,* 1931, p. 716) were wrong in accepting Dall's type designation. Wenz (Handbuch der Paläozool., vol. 6, Pt. 1, Lief, 6, 1941, p. 1123) credits Dall with citing *filosa* Gmelin (*lapillus* L.) as type, while Winkworth (Proc. Malac. Soc. London *26,* 1945, p. 141), credits him with giving *N. theobroma* as the type species. Both these statements are also erroneous, since Dall, on the one hand, merely listed *filosa* Menke (not *filosa* Gmelin) as an example (1909: 46), and, on the other hand, as Clench states, makes no mention at all of Röding's *theobroma.*

Clench, however, has overlooked Winkworth's earlier type designation (Journ. of Conch. *19,* 1932, p. 229), where he unequivocally gave *N. theobroma* Röding as type, without crediting it to Dall. This is the earliest valid type designation for *Nucella* that I have been able to discover.

The principal problem seems to be the identity of *Nucella theobroma* which Clench concludes must be considered a species dubia. Röding refers his species to *Buccinum filosum* Gmelin (Syst. Naturae, Ed. 13, vol. 1, Pt. 6, p. 3486), and follows the latter author in citing two figures in Martini (Conch.-Cabinet, vol. 3, 1777, p. 433, pl. 121, fig. 1113-1114) as illustrating the species.

Clench feels that these figures are unidentifiable, but to me it

seems to be evident on a number of counts that they represent a form of the common *Nucella lapillus* (Linnaeus). First of all, Martini himself, in the accompanying text, considers the shell a variety of *lapillus,* stating that it differs only in the color pattern; the locality he doubtfully gives as East Indies. Secondly, Röding has renamed the same shell again on page 132 of the "Museum Boltenianum" as *Nassa ligata,* again referring to *Buccinum filosum* Gmelin, and to the same figures in Martini. Here it is placed immediately next to *Nassa rudis* Röding, which as Clench points out, is merely a new name for *lapillus.* Thus it seems certain that Röding regarded *Buccinum filosum* as being close to *lapillus* Linnaeus. Finally, an examination of the U.S.N.M. collection of *Nucella lapillus* revealed a specimen, collected in France, that very closely resembles the figure given by Martini. On plate 10 I give a photograph of this specimen together with a reproduction of the figures of Martini. Considering the variability of the species, I am sure that specimens could be found that match the figure of Martini even more closely.

Polytropa Swianson, 1840 (Treatise Malacology, pp. 80, 305) is the next available name, and the one that Clench (op. cit.) used instead of *Nucella.* Swainson included in this genus *Purpura lapillus,* which Gray in 1847 (Proc. Zool. Soc. London, pt. 15, p. 138) designated as type. Thus *Polytropa,* it is true, is the first taxon that was fixed unequivocally on *lapillus,* but is a name that has been little used, and *Nucella,* as explained above, is clearly available for this group, and is earlier by 42 years.

A survey of the literature over the past 15 years, using the Zoological Record as a source, reveals that 18 authors used the name *Thais,* without subgeneric assignment, for the species *lapillus,* 4 (all American), used *Polytropa* (as a subgenus of *Thais*), and 14 authors used *Nucella,* all but two as a distinct genus, a procedure that Clench (op. cit.) suggested probably should be followed for this group.

AGGREGATIONS OF THE TERRESTRIAL PULMONATE CIONELLA LUBRICA

By ERNEST J. ROSCOE
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Widely distributed in Europe, Asia, and north Africa, *Cionella lubrica* (Müller) is generally spread over the North American

continent from northern Alaska to northern Mexico (Pilsbry, 1948). The species is quite ubiquitous within its range. Although there has been little work done on population density, collectors generally report that *C. lubrica* is difficult to obtain in quantity. Whenever large aggregations have been noticed, the observation has been thought of sufficient importance to place on record. Such recorded observations are summarized in the accompanying table, to which the following may now be added.

On October 27, 1960 Miss Maidi Wiebe, Staff Artist, Geology Department, Chicago Natural History Museum, observed a large aggregation of *C. lubrica,* probably totaling several hundred individuals, on the sidewalk in front of her apartment in Oak Park, Illinois, at about 7:30 A.M. The pavement was moist from a brief shower the preceding evening, although the adjacent ground was not particularly wet, the moisture having permeated into the soil. Air temperature was about 47° F. No other organisms were observed in association with the snails. At 5:00 P.M. Miss Wiebe noticed that about a fourth of the number of snails observed that morning were still present on the pavement. At 7:30 A.M. the following morning the snails had almost vanished. The temperature was somewhat higher, about 54° F., and the pavement was dry. Heavy rains fell on each of the following two days. A few snails were observed on the walk for a period of about 14 days, none being noticed thereafter.

The available data are insufficient to warrant drawing final conclusions. Some tentative suggestions do seem in order, and the summation will at least serve to call attention to the need for additional observations and to indicate the type of information required.

Aggregations of *C. lubrica* have been observed in widely scattered localities in North America, from Massachusetts and Pennsylvania to British Columbia. I have been unable to find references to any observed aggregations in the Old World. Quick (1954) states that *C. lubrica* is much more abundant that its close relative *C. lubricella* Porro in England.

The aggregations have occurred from late May or early June to late October. The majority of observations have been made in late summer or fall. Krull and Mapes (1952) have noted that these snails became increasingly numerous after September 1 in

central New York. They ascribed the greater numbers of snails observed in association with rocks at this time to the increased warmth and protection afforded by the stones.

The observed aggregations have generally occurred either during or preceding a storm. This would tend to support Henderson's (1905) suggestion that they are a response to physical factors. However, Mapes and Krull (1951) found collecting difficult even after a rain. Additional data on response to various environmental conditions is given in Krull and Mapes (1952). That such aggregations are for the purpose of reproduction has been suggested (Anon., 1946; Pilsbry, 1948). Possibly both physical and biological factors are involved, perhaps depending upon the season.

A hint of a cyclic phenomenon is contained in Clapp's (1914) statement that "in 25 years collecting in the Sewickley Valley [Pennsylvania] I have found this species decidedly rare." Long-time observations on populations of *C. lubrica* are necessary. I plan to keep tab on the Oak Park population during succeeding years.

Stephens (1918) found large numbers of these snails fastened by their secretions to the walls of a building, all with the apex of the shell directed downwards. This suggests some sort of oriented reaction (oriented behavior is discussed in Allee et al., 1949 and Warden et al., 1940). Possibly this behavior was a response to excessive ground moisture, Mapes and Krull (1951) noting that *C. lubrica* "is quickly activated and stimulated to climb up when submerged." About 100 of the Oak Park snails were kept under my observation for several days in a small petri dish, the bottom of which was covered by moistened newspaper. There was a noticeable tendency for the snails to concentrate in the center of the dish, in fact to form a pile of snails, when the paper was quite moist. As the paper dried out the snails tended to move out and distribute themselves more uniformly over the bottom. No mating activity was noticed during the relatively short observation period. Oriented behavior is discussed in Allee et al. (1949) and in Warden et al. (1940).

These aggregations of *C. lubrica* are in contrast to the difficulty experienced by Mapes and Krull in collecting this snail in central New York for experimental studies. Some of their collecting was

SUMMARY OF OBSERVATIONS ON AGGREGATIONS OF CIONELLA LUBRICA

Author & Date	Locality	Date of Observation	Substrate	Weather	Numbers Observed	Associated Organisms
Gould 1841; 1870	Oak Is., Chelsea, Massachusetts	October	surface of ground	after a warm rain	incalcuable	---
Binney & Bland 1869	---	---	---	---	immense in favorable localities	---
Henderson 1905	Cazenovia, New York	---	board sidewalk	appear 6-8 hours before rain	hundreds	---
Clapp 1914	Sewickley, Pennsylvania	middle of October and Nov. 30, 1941	flagstone walk	---	a lot - over 100 collected in a few minutes	Vallonia excentrica
Stephens 1918	Lake Okoboji, Iowa	Aug. 29, 1915	on door & frame of frame bldg. & on ground	cold rain preceeding night, followed by cold, drying wind	125 specimens collected	Vallonia gracilicosta & Gastrocopta armifera
Anon. 1946	Vernon, British Columbia	late May or early June, 1946	cement floor of demolished building	---	hundreds	earthworms
Wiebe 1960	Oak Park, Illinois	Oct. 27, 1960	paved sidewalk	brief shower preceeding night. Substrate still wet. Temp. 47°F.	hundreds - 100 collected in a few minutes	none observed

done near Cazenovia, the general locality of Henderson's (1905) observations. Mapes and Krull found it necessary to resort to the use of traps consisting of wet gunny sacks spread over the ground in suitable areas in order to obtain sufficient specimens. These traps, examined two or four times weekly, resulted in only 26 specimens per trap even in favorable sites and under favorable conditions. These authors are of the opinion that the requisite factors for large populations of *C. lubrica* are moist soil, almost constant shade, and a large quantity of suitable vegetation.

The materials required for the culture of *C. lubrica* are inexpensive, but such cultures do require a considerable amount of attention. Detailed instructions may be found in Mapes and Krull (1951). There is here an excellent opportunity for some interested amateur with the time at his disposal to make some very worthwhile observations on the biology of this snail.

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PUERTO RICAN HOLOPODOPES

By H. BURRINGTON BAKER

The name **Holopodopes** (plural of holopod-ops) is proposed here for an infraorder of the suborder Sigmurethra, to include the achatinoids (Achatinidae and Spiraxidae), Streptaxidae, rhytidoids (Acavidae proper + Caryodinae, Haplotrematidae, Rhytididae and Chlamydephoridae) and orthalicoids (Urocoptidae and Orthalicidae or Bulimulidae). In a systematic arrangement, they should precede the Aulacopoda (arionoids, limacoids and testacelloids) and the restricted Holopoda (polygyroids, oleacinoids and helicoids). Some of the reasons for the separation of the holopodopes have been outlined in an earlier paper (1955).

The symbols used for Puerto Rican localities were explained recently (1961).

Opeas pumilum (Pfeiffer). Es2 (coconut plantation).

The older name, *Helix hannensis* Rang, 1831, from West Africa, which may have been this species, now can be dropped as obsolete. The other widely distributed *Opeas, O. pyrgula* Schmacker & Boettger, which has less arcuate growth striae, probably also occurs in Puerto Rico, although it has not been reported, unless the older, but obsolete name, *Stenogyra alabastrina* Shuttleworth, from near San Juan, represented it. The more typical Ferussaciinae, *Cecilioides* (*Geostilbia*) *aperta* (Swainson) + *gundlachi* (Pfeiffer) and *C. (Karolus) consobrinus* (Orbigny), found by van der Schalie, 1948:50, 51, also have been distributed widely by commerce.

Lamellaxis (Leptopeas?) micra (Orbigny) and var. *margaritaceus* (Shuttleworth). Es2 (coconuts), Pn1 (yams), Wr2 (coffee), Wr3. All my dry shells (more in alcohol) nearer the smoother form, which is not limited to Puerto Rico; the obsolete name, *Stenogyra gompharium* Shuttleworth, from near San Juan, may have been based on the typical one.

Martens, 1877:345, reported the Cuban *L. (Leptopeas) paludinoides* (Orbigny) from Aguadilla (Ww), but I got neither it nor the ubiquitous *L. (Allopeas) gracilis* (Hutton), which may mean they are more limited to cultivated areas.

Lamellaxis (s. s.) monodon (C. B. Adams) and var. *opalescens* (Shuttleworth). Pn1, Pr3, Wr2, Wn; my only dry shell (Wr2) the imperforate form, which also occurs in Jamaica.

Obeliscus (Stenogyra) terebraster (Lamarck). Deep in humus, Er3, 5, Pr1-1, 6, Wr2, 3, 1800-4000 ft.; typical larger form.

O. (S.) TEREBRASTER RARISINISTER, new subspecies. En1, Es3, 4, Jn1 (type locality), Pn1; lowland form smaller throughout, not simply with less whorls. The type, Pilsbry, 1906 (16a):pl. 32, fig. 31, a sinistral shell (ANSP. 59320 from R. Swift) of this variety. It measures: 14.4 mm. by 28 (4.1 mm.) with 10½ whorls.

O. (S.) swiftianus (Pfeiffer). Ps2 (attains length of 10.5 mm., with 8.2 whorls) & Ws (smaller); this species has gone around the world.

O. (Pseudobalea) hasta (Pfeiffer). Under leaves on ground and in moss on tree trunks; Er2, Jn1, Pn, Pr3, 6, Wr, 100-3400 ft.

Since *Balea dominicensis* Pfr., 1853, from "I. Haiti," is identifiable only from its inclusion by Pfeiffer himself in the synonymy of *O. hasta,* the slightly older name is clearly obsolete, even if dated from Pilsbry, 1906 (16a):272.

Subulina octona (Bruguière). On ground under dead leaves; Ee, En, Es2-4, Jn, Js, Pn, Pr2, 3, Ps, Wn, Wrl, Ws, Ww; 0-3400 ft.

The obsolete *Stenogyra (Subulina) acicularis* Shuttleworth, based on one shell from near Fajardo, seems to be represented in some eastern lots (Ee, Es2) from near the seashore by occasional dwarfed shells (with fewer whorls, but sexually mature) which have more deeply etched, growth striae, that do crenulate the sutures.

Leptinaria unilamellata (Orbigny). Widely reported by van der Schalie, 1948:56, probably from cultivated places.

Very unfortunately, I, 1945:91, adopted Orbigny's prior name before the more widely used *L. lamellata* (Potiez & Michaud) would have been saved by the 50 year "rule." Recently, Aguayo, 1961:94, added the other, equally ubiquitous, but more terrestrial *L? (Beckianum) beckianum* (Pfeiffer), which already was known from both the Virgins and Haiti.

Austroselenites (Zophos) alticola H. B. Baker. Deep in leaf humus, Er2-4, and probably Er1 and 5 (too young for exact identification); certainly above 2500 ft. on El Yunque and probably Luquillo Mts. above 2000.

A. (Z.) concolor (Férussac). Also terrestrial, En 3, 4, Jn, Pn, Pr1, 3, 4, Wr3, and probably Pr 2, 6, Wn, Wr2 (too young); certainly on lowlands, and apparently represented by a smaller, darker race up to 4000 ft. in the Cordillera Central, but my material is too scanty for certainty.

The widely transported streptaxid, *Diaphera (Huttonella)*

bicolor (Hutton) was found by van der Schalie, 1948:68. *Diaphera* Albers, 1850, of which *Diaphora* Albers-Martens, 1860, is a homonymic emendation, is prior to *Gulella* Pfr., 1856, and *D. bicolor* is the type (Nevill, 1878) of *Huttonella* Pfr., also 1856, of which *Indoennea* Kobelt, 1904, is a subjective synonym.

Brachypodella (s. s.) riisei (Pfeiffer). Lowlands, En, Jn, Pn, Wn, Ws.

B. (s. s.) pallida ("Pfeiffer" Philippi). Lowlands, En, Jn; Ps2 *(beattyi)*; Ws (approaching *beattyi*).

B. (Brevipedella) portoricana (Pfeiffer). En, Jn, Pn, Wn, Wr2, 0-2300 ft.

These 3 species of *Brachypodella* may occur within a few feet of each other on limestone rocks, but B. *portoricana,* much the poorest climber, was the only one found (Wr2) far from the limestone rim, and *B. pallida,* the best climber, was the only species collected at the driest station (Ps2), where it was buried quite deeply under rocks. Besides their difference in habits, these shells from Ps2 do average smaller and commonly their last whorls are less widely solute (some almost adnate) but the "differs" in riblets seem individual variation. Some are about the size of typical *beattyi* Clench, 1951:251, fig. 3, from Mona Island; one with all 17 whorls measures 10.3 mm. (over all) by 2.1 (not including aperture). Many more were found intact but even a little shaking rendered them decollate.

Pseudopineria viequensis (Pfeiffer). In holes and under overhang of cliffs, on or beneath the limestone outcrops of the northern rim, commonly in shaded places where *Brachypodella* was absent; Jn1, 2. Foot whitish; ommatophores translucent, cylindric, with black eyes; inferior tentacles small but certainly present; sole unizonal, with 1 or 2 waves that involve its full width.

Macroceramus microdon (Pfeiffer). Pilsbry, 1903 (25a):115-116, pl. 24, figs. 71-72 (ANSP. 25117 & 25115, from R. Swift); van der Schalie, 1948:map 62, pl. 7, figs. 2a, 2b. En, Jn; growth threads narrower than their interspaces (much more so on subapical whorls) and irregularly spaced on later whorls.

The obsolete *M. johannis* Pfeiffer appears indistinguishable, and Aguadilla falls within the range of the typical subspecies.

M. microdon, var. *shuttleworthi* (Martens), 1877:352 (?), without exact locality. Pilsbry, fig. 74 (ANSP. 2572, from Bland); van der Schalie: fig. 2c. Ws: largest 18.7 mm. long with 12 whorls. Ps2: 1 adult 18.8 mm. long (decollate) and 2 immature, one of which approaches *loeryi* in growth threads.

M. microdon loeryi Jacobson, 1955. Ps2 (near type locality);

one adult and 1 immature, empty shells; look as if started life like var. a, but assumed later whorls of var. b, which see. Adult 14.1 mm. by 55 (7.7 mm.) with 7 whorls remaining.

M. microdon loeryi, var. a. Ps2, 3. Shells about size and form of typical *microdon;* one (Ps2) measures: 14.1 mm. by 36 (5.0 mm.) with 11.2 whorls; ranging to 17.2 mm. long with 12.6 whorls; without bluish tinge when alive; 1 shell unicolor, without white patches.

M. microdon loeryi, var. b. (?) *M. shuttleworthi* Martens, 1891: 132, Penuelas. Under bunch grass, but climbing 4 to 6 ft. during rain; near Tallaboa (Ps1). Shell with growth threads, especially on later whorls, broader than their interspaces and quite evenly and closely spaced; and those on subapical whorls less widely spaced than in typical *microdon.* Predominant color of shell light sky-blue on living examples but now (1960) almost completely faded to whitish (opaque) with narrow, light brownish (translucent) growth (axial) bands, as were empty shells found nearby (one of last unicolor, without whitish patches); with almost no trace of basal angulation in many; largest 21.1 by 37 (7.8 mm.), minor diam. 33 (6.9 mm.) with 13.2 whorls; smallest 19.8 mm. long with 11 whorls remaining. Living animal light slate color, darker near sole and on ommatophores; mantle collar dark brownish gray, with minute light spots; sole unizonal, with 1 or 2 locomotor waves across its full width.

In 1939, var. b. was considered a subspecies of *M. microdon* (Cf. van der Schalie:96) but I hesitated to name it because of the doubt about the true *M. shuttleworthi,* which Martens later located at the nearby Penuelas. The above presents the old notes, with a few changes; typical *loeryi* and var. a were included, as now.

Microceramus (s. s.) guanicus H. B. Baker. On rocks near ground; only known from type locality (Ps2) and Mona Island (Clench, 1951).

Bulimulus (s. s.) guadalupensis (Bruguière). On ground and tree trunks up to 5 ft., Ee, Es2 (coconut plantation), Es4, Jn1, Ps4 (garden), Ww1 (garden).

For this widely disseminated pest, van der Schalie, 1948:87, returned to *B. exilis* (Gmelin).

B. (s. s.) diaphanus (Pfeiffer). More terrestrial, Pn1, Pr2, 4, Ps2, 3, Wn, Ws; 0-3100 ft. Shell epidermis rufous (typical) to whitish.

This may be a native species, although described originally from St. Thomas. Pilsbry's, 1897 (9b):46-47, transference to this species of the Puerto Rican records of the now obsolete *B. fraterculus*

("Fér." Potiez & Michaud, 1838) is accepted; certainly nothing like the original (P. & M.) figures has been found since. The last name was nude in Férussac, 1821, livr. 11:54, and in Beck, 1837:67, although Beck questioningly (?) referred it to *Helix tenuissima* Férussac, 1832 (+ Orbigny, 1835?).

Drymaeus (Mesembrinus) virgulatus (Férussac, 1821) and color form (?) *liliaceus* (Fér., 1832). Arboreal, edges of Ps1 (30% *liliaceus*) and Ps2 (45% *liliaceus*); empty shells seen elsewhere but only near cultivated places.

The separation of these two lots into *liliaceus* (complete absence of brownish color) and *virgulatus* (with even a few streaks, up to axial and/or spiral bands of variable continuity) seems highly arbitrary. Confessedly, most of the "lilies" have a less elongate (Röding) form and a slightly swollen last whorl, but they include the most elongate[1] shell in the series, and typical *virgulatus* covers almost the entire range of shell form. These may be hybrids (of an introduced with a native form?) but they cast doubt on any specific separation, even if it has continued for 130 years.

D. (M.) multilineatus (Say); Cf. form *osmenti* Clench and/or *eboreus* Grimshawe. Along road to Wn. One shell from living adult resembling in form, texture and coloration those of Pilsbry, 1946 (11):27, figs. 15b, with similar columellar blotch (absent in thicker and chalkier *D. virgulatus*) and slightly wider, sutural stripe, but lacking all other dark bands except 4 (plus traces) axial streaks near aperture, and showing no signs of characteristic bluish color near apex. Another shell too broken and bleached to be sure of its form, with similar columellar patch and axial streaks, but without sutural stripe.

Neither fits the obsolete *Drymaeus hjalmarsoni* (Pfr.), from "near Manati" (between Jn and Pn), which, as Pilsbry (1899) suggested, seems to have been close to his (1946) *Leptodrymaeus,* and even might be the subsequently named *D. dormani* (W. G. Binney).

Simpulopsis (Eudioptus?) psidii (Martens, 1877). Not obtained.

From field notes, the young shells of *Platysuccinea* from the Cordillera Central, which approach it in height of spire, were confused with this arboreal species, and thus no special search

[1] More so than *beattyi* Clench, 1951: fig. 6, but less so than his type, figs. 4 & 5.

was made for it west of Utuado (between Wr6 and Pn1). However, a shell of the sagdid at the size of *S. psidii* (5 by 5 mm.) has one less whorl (2 vs. 3); being small, mature *S. psidii* might be found only near the end of a long rainy period. Pilsbry, 1902 (31):1xvii, included both *Eudioptus* Albers-Martens (not a homonym) and *Platysuccinea* in the bulimulid *Simpulopsis,* but no geophile systematist in this century has guessed either to be a *"Bulimulus."* The type species of *Eudioptus,* in which Martens placed his *"Bulimus"* psidii, is Brazilian, but a dweller on guava leaves might be carried by commerce.

Gaeotis nigrolineata Shuttleworth. Mainly on leaves of palms, but also on those of *Cecropia* and other trees, Er3, 4, 5; in axils of palm pinnae, Wr3; from Luquillo Mts. to western end of the Cordillera Central; 2000-3000 ft. Living animal (Er) 3 by 1½ inches (76 by 38 mm.); yellowish green, but variable; dorsum of foot slaty with yellow middorsal stripe *(flavolineata)* which often becomes double anteriad; and often with frosty, whitish patches (like *albopunctulata?*); sides and inferior tentacles lighter, but sole often with orange margin on anterior ⅓ *(flavolineata)*; ommatophores blue green, but eyes lighter; mantle (over shell) pea green; often with (internal) black streaks visible *(nigrolineata).*

Very flimsy shell "sigaretiform" but thin lower surface of apical whorls present and containing those of animal, so that separation in preserved examples means damage to one or the other (shells still on most of mine). Lower surface of apical whorls broken away from all 6 shells studied by Pilsbry, 1899 (35):227-231, as follows: ANSP. 4613, one labeled *"albopunctulata"* and one (4614) *"nigrolineata"* from Humacao (Bland). ANSP. 26052, type lot of *malleata;* 2 shells from "near San Juan," from Swift, collected in 1855. ANSP. 4959, one juvenile labeled *"flavolineata"* by Bland (not by Pilsbry) from "Luquillo." ANSP. 26051, labeled *"nigrolineata"* from "Pto. Rico" (Swift).

G. nigrolineata is the type species of *Gaeotis,* by subsequent designation of Kobelt, 1880, Ill. Conch.:264. Although only preliminary dissections have been made as yet, all my material looks like one variable species, but none of it comes from the lowlands (secretive during dry weather?). On El Yunque, this bulimulid slug was fairly common, but its coloration blends with the leaves.

Additional references (See 1961)

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JULIA ANNA GARDNER
1882-1960

Julia Anna Gardner, known around the world for her work in stratigraphy and molluscan paleontology, died after a long illness on November 15, 1960. She was a geologist with the United States Geological Survey for 32 years.

Julia Gardner was born in Chamberlain, South Dakota, on January 26, 1882. Her undergraduate studies were done at Bryn Mawr College where she received the Bachelor of Arts degree in 1905 and the Masters degree in 1907. Miss Gardner entered The Johns Hopkins University in the fall of 1907, the first woman regularly admitted to the Department of Geology. After receiving her doctoral degree in 1911, she continued there as Assistant in Paleontology until 1915. Her studies of the Late Cretaceous Mollusca of Maryland and other smaller groups were published by the Maryland Geological Survey in 1916. In 1915 she began work on the Miocene Alum Bluff Group of Florida under contract with the United States Geological Survey.

During World War I, the broad and specific humanitarianism which characterized her life impelled her to go to France with the Red Cross in 1917. She saw strenuous service as an Auxiliary Nurse and after the war with the American Friends in the devastated areas of France.

Upon her return to the United States in 1920, Miss Gardner joined the Geological Survey and took up again her professional career, which was to become long and distinguished.

She was the author of over 40 reports. Pre-eminent among these are:

The molluscan fauna of the Alum Bluff group of Florida: U. S. Geol. Survey Prof. Paper 142, 1926-1947.

The Midway group of Texas: Texas Univ. Bull. 3301, 1933 [1935].

The Mollusca of the Tertiary formations of northeast Mexico: Geol. Soc. America Mem. 11, 1947.

Their scientific value was equaled by their usefulness in the field of petroleum geology, and they are standards of reference in the economic investigations of Tertiary strata of both North and South America. Her published works are foundation stones and bench marks in Coastal Plain stratigraphy and paleontology

that insure Julia Gardner a high place with the pioneers in the geology of the region.

Among the societies of which Miss Gardner was a member are Phi Beta Kappa; Sigma Xi; the Geological Society of America, of which she was a fellow and vice president in 1953; the American Association of Petroleum Geologists; and the Paleontological Society, which she served as president in 1952. She was a charter member of the American Malacological Union and was widely known and loved by collectors everywhere.

She was an official delegate of the United States to the International Geological Congress in Madrid in 1926, and to the International Congress in Moscow in 1937.

Julia Gardner made a great contribution in her chosen field of geology; an equally great contribution in the field of human relationship may be exemplified by her encouragement of the Japanese scientists while on a tour of duty in Japan after World War II. They confirm that her kindness and generosity heartened them to carry on their researches. In her wide circle of friends, few do not have cause to remember some kindness, some encouragement, some tangible assistance, timely, but given unexpectedly. Julia Anna Gardner will live long in the hearts of her friends. — Druid Wilson.

NOTES AND NEWS

Pomacea paludosa in Alabama — In 1943, John Richardson II collected *Pomacea paludosa* (Say) at Gainesville, Florida, and introduced it into ponds on his farm 7 miles north of Jacksonville, Florida. From here, in 1953, Frank Lyman introduced it into a small pond on the shore of Gantt Lake, 5 miles northeast of Gantt, Covington Co., Alabama. It soon escaped into Gantt Lake, and is now to be found along the shore for a mile in either direction from Lyman's pond. — Leslie Hubricht.

Succinea indiana Pilsbry.

Succinea indiana Pilsbry, 1905, Nautilus, *19:* 28.

Succinea vaginacontorta Lee, 1951, Occas. Papers Mus. Zool. Univ. Mich. no. 533, pp. 1-7, Pl. 1-2.

A careful examination of the anatomy and shell of topotypes

Succinea indiana showed no character which could be used to distinguish it from *S. vaginacontorta*. The same twisted vagina is found in *S. indiana*. *S. vaginacontorta* Lee must be placed in the synonomy of *S. indiana*.

Additional records for *Succinea indiana* are as follows: *North Carolina:* Craven Co.: sandy roadside, 4.4 miles west of New Bern. *South Carolina:* McCormick Co.: below Clark Hill Dam. *Georgia:* Richmond Co.: roadside, 1600 Gordon Highway, Augusta. Alabama: Montgomery Co.: waste ground, Atlanta Highway and Forest Hills Ave., Montgomery. Dallas Co.: near Alabama River, opposite Selma. — Leslie Hubricht.[1]

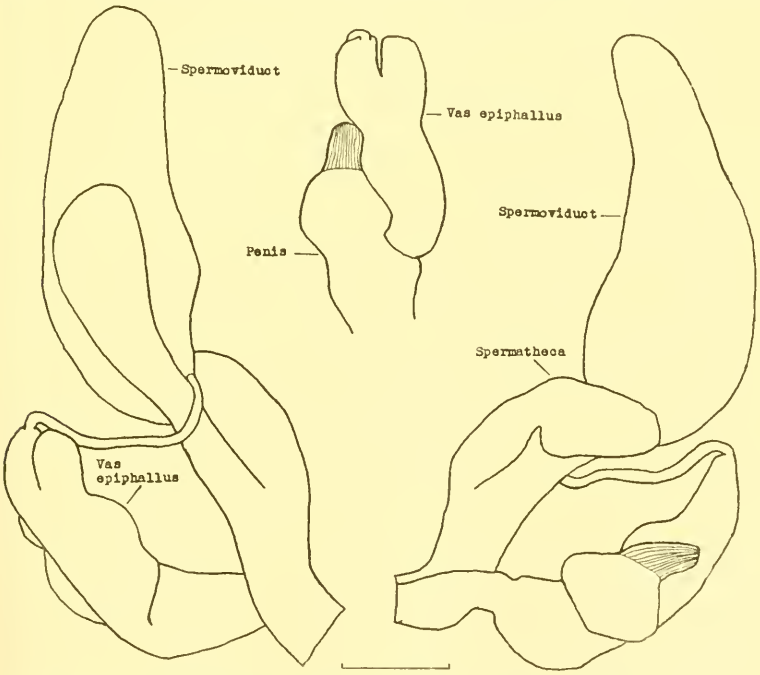
Viviparus subpurpureus in Oklahoma. — A single specimen, 33.0 mm. in height and 32.0 mm. in greater diameter, of this species was discovered in a small, mud-bottomed, heavily-vegetated stream at the south boundary of Tom, McCurtain County, Oklahoma on 16 July, 1961. The spire was greatly eroded. Although this specimen represents a new record for Oklahoma, it is not a particularly surprising one. The Austroriparian Biotic Province extends into Oklahoma at this point but it is separated from the main body of that ecological division by the Red River. *Viviparus subpurpureus* (Say) is a fairly common species in adjacent Texas and Louisiana but apparently has met some difficulty in traversing the river barrier into Oklahoma, as I have collected rather extensively in this part of the state and have not found the species before. — Branley A. Branson, Dept. of Biology, Kansas State College, Pittsburg.

Helisoma anceps transported by a giant water bug. — On 5 May, 1961, I collected a giant water bug, *Lethocerus americanus* (Leidy), which had been attracted (at night) to a 100-watt mercury lamp on a lawn at the University of Michigan's Erwin S. George Reserve, Livingston County, Michigan. The bug was carrying on its scutellum a specimen of *Helisoma anceps* (Menke). The snail was alive and appeared to be immature, measuring 5 mm. high and 7 mm. long. Giant water bugs of this species and a similar species, *Benacus griseus* (Say), frequently come to lights in early spring and later in the summer; evidently

[1] Accidentally omitted from Naut. 75:60. — H. B. B.

there is much movement between ponds, presumably associated with mating behavior. Any animal that happened to become attached to a bug would be similarly transported. During 1959-61, I examined about 500 of these bugs, but this is the only occasion I found an attached snail. But among several hundred hydrophilid beetles similarly attracted to light, I found 3 with immature leeches attached to their elytra. The leeches at first appeared dead, but quickly became active when placed in water. In view of frequent speculation as to how totally aquatic animals colonize isolated ponds, these records may be of interest. — D. F. Owen, Museum of Zoology, University of Michigan, Ann Arbor.

The anatomy of glyphyalinia junaluskana.—*Glyphyalinia junaluskana* (Clench & Banks) generally has been treated as a subspecies of *G. sculptilis* (Bland). However, a study of the genitalia shows that it is quite distinct. The following description of the lower genitalia is based on a specimen collected at



Glyphyalinia junaluskana (Clench & Banks). Three views of terminal genitalia, drawn with aid of camera lucida. Scale line = 1 mm.

4700 ft., 0.6 mile southeast of Beech Gap, Graham Co., North Carolina.

Penis (fig.) rather short and stout, club-shaped, basal portion nearly white; upper portion pale brownish, globose. Penial retractor short and stout, inserted at apex of penis. Epiphallus parallel to penis, long and stout, as large as the penis; upper end deeply cleft into two equal lobes; lower portion pale brown, becoming darker at upper end. Spermatheca narrowly obovate, not clearly differentiated from the thick duct. Vagina and free oviduct short.

It differs from *G. sculptilis* in being without the penial appendix of that species and in having the epiphallus divided into two distinct lobes. It apparently belongs in section *Glyphyalinia*. s. s rather than in section *Glyphognomon* H. B. Baker.—Leslie Hubricht.

Corbicula fluminea (Müller) from the Ohio River—On a field trip last August 30, 1960, to the Ohio River just east of Fort Massac and Metropolis in Massac County, Illinois, I collected 11 recently dead specimens of *Corbicula (Corbicula) fluminea*. They were 15-20 feet from the north bank in 6″ of water. The bottom was more gravel than sand with very little mud present. The areas on either side were muddy bottoms and about one foot deep, yet no specimens were found.

Corbicula fluminea, a native of eastern Asia, has not been reported from the northeast or central states as of this writing; therefore, I can mention those collected at Metropolis, Illinois, as new in this part of the country. Sinclair and Ingram (1961, Naut. *74*:114-118) reported the species' presence in the Tennessee River in Hardin County, Tennessee. Previously, the species was known only from the south to north western states, i.e., Arizona, California, Idaho, Nevada, Oregon and Washington (op. cit.). *Corbicula fluminea* seems to be widely distributed over the United States. Records of its further spread are to be expected with additional collecting.

Since I am not an expert on foreign shells, the specimens were submitted to Dr. Fritz Haas of Chicago Natural History Museum for identification. They are now Chicago Natural History Museum No. 103678. Sincere appreciation is extended to Dr. Haas for his assistance.—Frederick R. Fechtner.

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A NEGLECTED WEST ATLANTIC STROMB

By A. A. OLSSON and D. R. MOORE

In 1949, Mr. Leo A. Burry described and figured (Shell Notes, December, 1949), a most unusual *Strombus* under the name of *S. canaliculatus,* reported as having been taken in a fish-trap set at a depth of 175 fathoms off Hopetown, Elbow Key in the Bahamas. The whereabouts of the type is unknown. The figure shows an immature specimen in which the lip is not yet fully formed. Subsequent to the description of the species, the junior author saw 3 additional specimens which Burry had obtained from the same source. Two specimens were half grown and smaller than the holotype, the third was fully matured with a flared and thickened outer lip. This last specimen, a topotype, is in the reference collection of the Marine Laboratory of the University of Miami (Accession no. 30:1839). It measures 242 mm. in length. (Plate 11.)

The full-grown shell has a high, broad, conic spire of 8 or more whorls, each edged with a sharp, peripheral keel or carina, the main surface of each spire-whorl smooth, except for the fine lines of growth. There are no axial riblets at any stage. The peripheral keel becomes more strongly emphasized on the shoulder of the body-whorl and at its termination on the edge of the outer lip it forms into a deep notch. The wall of the shell is quite heavy, interior of aperture with a pink coloration and the surface is covered with the usual, light-brown, peeling periostracum. The report that this shell was taken from a fish-trap seems very questionable. There seems to be nothing closely related to *S. canaliculatus* in the living fauna; *S. leidyi* Heilprin of the Florida Pliocene is perhaps the nearest, but even in this case, the resemblance is not close.

The collection of at least 4 typical specimens of *S. canaliculatus* in a relatively short time and from the same general area seems to preclude a chance anomaly or a deformed or diseased shell. The absence of axial ribbing on any part of the whorls of the

spire is again emphasized. More material with accurate data as to station and environment is needed and we are calling renewed attention to this interesting species so that collectors visiting the Bahamas can be on the watch for it.

THE STATUS OF STROMBUS CANALICULATUS

By ROBERT ROBERTSON
Assistant Curator of Mollusks,
Academy of Natural Sciences of Philadelphia

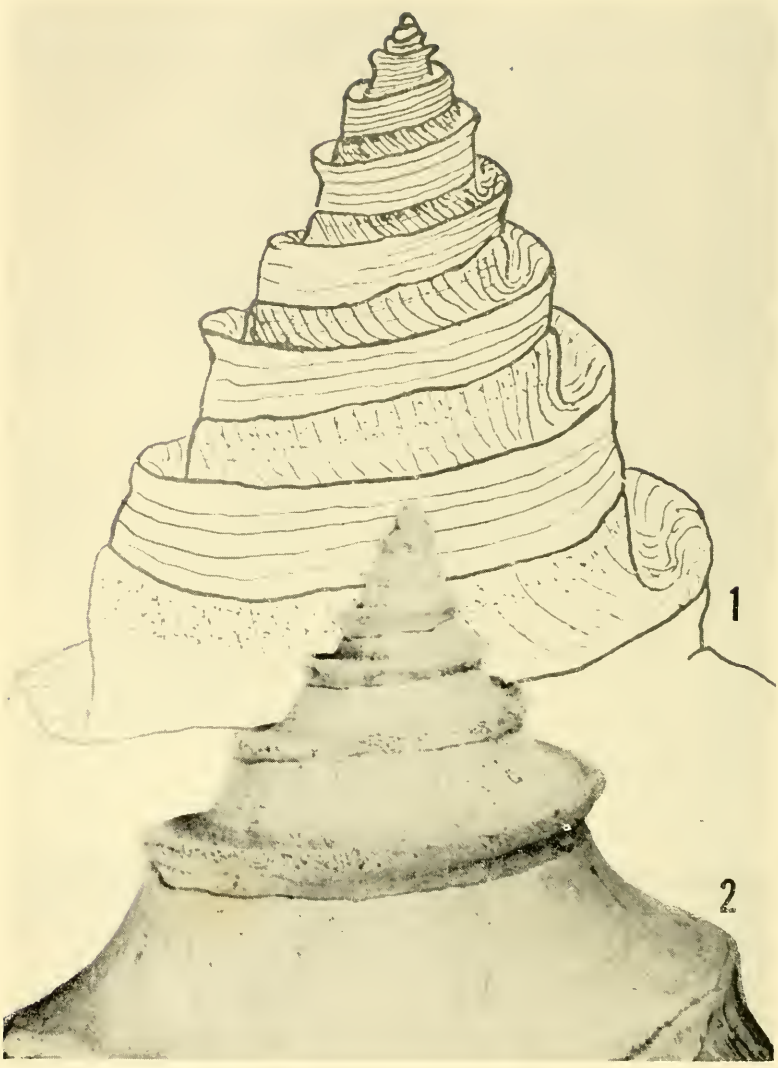
Olsson & Moore (1962) have claimed that *Strombus canaliculatus* Burry (1949) is a distinct, "neglected" species, not closely related to any other living species. They have discounted the idea that the 4 known specimens are abnormal.

S. canaliculatus was originally described on the basis of a single, sub-adult shell, purportedly from a fish trap in 175 fathoms off Hope Town, Elbow Cay, Great Abaco, Bahama Islands. The trustworthiness of this type locality has bearing on the validity of this species. If, as Olsson has suggested (*in litt.*), it is a deep water, "outer shelf" species, it could have been overlooked.

Unfortunately, Burry gave no information as to how he obtained the holotype. According to D. R. Moore (*in litt.*), Burry obtained it from a man named Ford [not Rev. Paul D.], who had a shop in Riviera Beach, Florida, and who imported shells from the Bahamas. Possibly, Ford bought the shell from a fisherman. There are four reasons to doubt that this shell (collected alive) came from 175 fathoms off Hope Town: (1). Although detritus feeders can live at great depths, I doubt that such a large, herbivorous gastropod (Robertson, 1961) could live at 175 fathoms, well below the photosynthetic zone.[1] (2). The escarpment bounding the Little Bahama Bank off Hope Town is precipitous. The margin of the Bank is at a depth of 55-70 fathoms (personal observations); soundings of about 1000 fathoms are recorded as near as 5 miles to the Bank (see H.O. chart 0026e). (3). The currents off Abaco are so strong (2-3 knots) that retrieval of a fish trap from 175 fathoms would be

[1] Various *Strombus* species, all smaller than *S. canaliculatus*, are known definitely to live in depths of at least 30-43 fathoms, but not deeper. A tiny species has been dredged alive in the Hawaiian Islands between 43 and 66 fathoms (see Abbott, 1960, pp. 83-84).

Figs. 1-3. *Strombus canaliculatus* Burry. Length: 242 mm.



Spires of malformed, carinate *Strombus (Tricornis) gigas* Linn. Bahama Islands (?). Fig. 1. Holotype of *S. canaliculatus* Burry. Drawing by Gilbert L. Voss in Burry (1949). Fig. 2. Purported "topotype" of *S. canaliculatus*. Same shell as that figured by Olsson & Moore (1962). Both figs. approx. natural size.

impossible without equipment not available to local fishermen, who do not place their fish traps ("pots") outside the reef. (4). During 3 summers (1953-1955) while collecting shells at Hope Town, I was unable to get any information from the local fishermen about the finding of *S. canaliculatus*. These fishermen remembered details about shells of commercial value collected years before.

In view of these 4 reasons to doubt that the holotype came from 175 fathoms off Hope Town, it is improbable that the other 3 specimens of *S. canaliculatus* (see Olsson & Moore) came precisely "from the same source [locality]". Olsson & Moore concede that they doubt that the "topotype" figured by them was taken from a fish trap. Lyman (1951) reported that the adult specimen (presumably the "topotype") "was brought in from the Bahamas and delivered to Mr. Burry." Thus, there is no compelling evidence that any of these 4 shells came from deep water, or even from the vicinity of Hope Town.

The shell figured by Olsson & Moore, identified by them as *S. canaliculatus,* differs significantly from the holotype. Oriented conventionally, the holotype (Plate 12, fig. 1) has a high spiral ridge projecting vertically from each whorl of the spire, forming a deep channel near the suture. A similar ridge projects laterally on the shell figured by Olsson & Moore (Plate 12, fig. 2); there is no deep channel. In addition, the spires of the 2 shells are of different heights.

In my opinion, the name *S. canaliculatus* has been applied to malformed shells of *S. (Tricornis) gigas* Linn. The holotype of *S. canaliculatus* (255 mm. long) and the shell figured by Olsson & Moore (242 mm. long) are both the normal size of adult and sub-adult *S. gigas*. A congenital defect of a small part of the mantle laying down the shell material of the posterior part of the outer lip, or an injury at an early age, would account for all the morphological differences (including the suppression of spines and axial sculpture), and for the differences in the form of the spiral ridge if the position of the defective part of the mantle varies. There are other striking malformations of *S. gigas* (see M. Smith, 1940, and M.C.Z. no. 168409; Salisbury, 1953), and similar carinate malformations due to mantle defects occur in many other gastropods (Pelseneer, 1920; for more examples,

see Crosse, 1881; Sykes, 1903; Dautzenberg, 1911).

A malformed shell of *S. (Strombus) pugilis alatus* Gmelin (Plate 13) corresponds in part to *S. canaliculatus*. On the last 1½ whorls a vertical spiral ridge forms a deep channel near the suture. Growth was normal until the outer lip was twice broken.

La Fontaine (1875) and Abbott (1960, p. 112) discuss 2 more malformed, carinate *Strombus,* one (*S. vittatus* Linn.) canaliculate.

A simple experiment might prove beyond question that *S. canaliculatus* is a malformed shell. The appropriate portion of the mantle of juvenile *S. gigas* could be artificially damaged in order to observe the effects on the subsequently formed outer lip of the shell.

In 1951, 2 years after describing *S. canaliculatus* and about 1½ years before his death (in Dec., 1952), Leo A. Burry admitted to William J. Clench and Ruth D. Turner that he then believed he had named a malformed shell. The additional specimens were in Burry's possession at that time.

Acknowledgment: Axel A. Olsson graciously provided the excellent photograph of the spire of *S. canaliculatus,* and courteously allowed me to read the manuscript of his paper co-authored with Donald R. Moore.

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VARIATION AND CHANGE IN SURFACE SCULPTURE IN ANOMIA ACULEATA

By ARTHUR S. MERRILL[1]

Surface sculpturing on the shell of *Anomia aculeata* Gmelin varies considerably (Verrill and Smith, 1873; Jackson, 1890; Whiteaves, 1901; and Foster, 1937) ranging from smooth to highly spinose. In fact, lacking intermediates, the variants at the extremes could be easily mistaken for separate species. One, accordingly, might expect to find grave nomenclatorial difficulties in the literature but this is not the case. The smoother of the individuals are still occasionally listed with "form" or "varietal" names but it is generally well understood that they are part of a single species complex.

With ample material available, this study was undertaken simply to describe the degree and complexity of sculptural variation normally occurring in this species. As the study progressed I found that spinosity, if it is expressed, develops at widely differing shell sizes. In the usual lamellibranch, a character which develops in the postlarval form becomes apparent at about the same age in all specimens. But in *A. aculeata,* this laboratory has individuals whose variability for the characteristic spinosity may be expressed any time after metamorphosis.

This paper, then, describes variability in *A. aculeata* and presents data to show the change in ratio of smooth to spiny individuals with reference to shell size.

Methods of Collecting and Measuring. Most of the material used in this study came from navigation buoys stationed in offshore waters south of Nantucket, Massachusetts. Since buoys are brought in periodically for cleaning and servicing, the many forms of life found attached can be removed for study. *Anomia* often homesteads the convenient buoy surfaces, after the initial pelagic larval stage, instead of settling in its usual habitat on the bottom. Because smaller *Anomia* were predominant on the buoys sampled, the bottom was dredged to obtain representatives of the larger adult sizes.

A. aculeata usually maintains a suborbicular shape during

[1] U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries Biological Laboratory, Woods Hole, Massachusetts.

growth. Those which, by some accident of position, meet an obstacle in the immediate vicinity assume various distorted shapes in an effort to circumvent the impediments. This apparently does not affect the morphology greatly other than to shift the axis of growth. The shape may become transversely elongated, or, more commonly, irregularly rounded. Thus, to better indicate true shell size, measurements of both the height and length were taken, added together, and the result divided by 2. Over 4,000 specimens, from newly settled larvae to mature adults, were examined.

Variation in surface structure. A. aculeata derives its specific name from the spinous and/or foliaceous character of its surface. While most individuals exhibit some degree of surface ornamentation, many individuals are entirely smooth. Foster (1937), reporting on specimens brought up attached to shells from fairly deep water on Georges Bank, described considerable variation in the spines, but, lacking smooth individuals, he did not describe this condition. Verrill (Verrill and Smith, 1873) mentioned variations in *A. aculeata* from the Bay of Fundy and the Casco Bay areas and described a variety with the scales "more or less absorptive or even entirely absent." Jackson (1890) and Whiteaves (1901) briefly discussed the smooth form.

Plate 14 illustrates the variation found in the surface sculpture of this species. On individuals with well-developed spines, the spines may radiate to the ventral margin at regular, well-spaced intervals. On others, they may be irregularly or more closely spaced. The spines may be seated on raised ridges or may simply arise from the surface.

Concentric lines form at intervals as the shell grows. The spines terminate at the line formed at the end of each of these growth intervals, and other spines commence to form with renewed shell growth. The degree of fluted, frilled, or other transverse sculpture depends on the degree of development of concentric processes. For example, on those with closely spaced and conspicuous growth lines, the spines are blunted. Often those with weaker growth lines tend to have spines which project from radiating ridges. The spines may also lack radial symmetry and simply form along concentric lines apparently at random over the shell surface.

On those individuals with smooth surfaces, the concentric growth lines are slightly undulate causing the surface to appear craggy or scaly. Very few have the smooth and glittering surface of the allied species, *A. simplex* Orbigny; usually the surface appears dull and chalky.

Practically every conceivable combination occurs between plain smooth and fully scaly individuals. Those not quite smooth may have faint ridges, perhaps just a ray or two in some; others may have a full fan of strong ridges with no sign of spines. On some with ridges, there may be a raised spine here and there, or possibly one of the ridges will be fully spined with none of the other ridges showing the slightest tendency to spininess. Some will be smooth to a certain stage in growth, then suddenly begin producing nicely developed spines. Others may do this and then just as suddenly become smooth again. There is seemingly no end to the possible combinations. For the purpose of this paper, the individuals have been separated into two recognizable categories: those lacking surface ornamentation, and those showing surface sculpture to various degrees. The latter include individuals whose sculpture ranges from faintly rayed to heavily spinose.

Size-frequency data by station: As mentioned earlier, population samples of *A. aculeata* were taken from 3 offshore buoys as well as from the bottom by dredging. Table 1 lists the frequency distribution from all stations as well as the percentage of smooth *Anomia* in each size category. The station locations and other data relating to them are listed below.

Nantucket Shoals Lightship Buoy (NSLS). The NSLS buoy, located 1 mile, 55° true, north of the permanent Nantucket Shoals Lightship at 40° 33′ N. latitude and 69° 28′ W. longitude, was placed on station October 8, 1957. When removed May 10, 1958, it had been in the water for 7 months. An estimated 25,000-30,000 specimens of *A. aculeata* were attached to the buoy. The sample used for this study consisted of 2,423 specimens.

Davis Shoals Buoy (4DS#1). The station occupied by the 4DS#1 buoy is about 25 miles west-northwest of the NSLS buoy at 40° 57′ N. latitude and 69° 55′ W. longitude. This buoy was on station 1 year from May 7, 1957, to May 15, 1958. The sample taken from this buoy included 537 specimens of *A. aculeata.*

Table 1.--Length frequencies by one mm. size groups and percentage of smooth Anomia aculeata from all stations

	NSLS Buoy		4DS Buoy #1		4DS Buoy #2		Channel		All stations	
Size	No. of specimens	Percentage of smooth	No. of specimens	Percentage of smooth	No. of specimens	Percentage of smooth	No. of specimens	Percentage of smooth	Total no. of specimens	Percentage of smooth
1	132	92.	1	100.	244	93.	--	--	377	92.
2	313	71.	6	100.	409	67.	--	--	728	69.
3	376	62.	3	33.	173	42.	--	--	552	56.
4	439	52.	10	30.	94	32.	--	--	543	48.
5	367	51.	31	16.	35	31.	--	--	433	47.
6	252	52.	50	26.	15	33.	2	50.	319	47.
7	217	42.	50	20.	8	25.	1	100.	276	37.
8	165	46.	64	27.	3	33.	4	25.	236	40.
9	93	36.	67	24.	--	--	14	29.	174	30.
10	49	41.	81	20.	1	0.	11	27.	142	27.
11	14	71.	78	26.	--	--	44	18.	136	28.
12	3	33.	48	38.	--	--	35	23.	86	31.
13	3	100.	28	21.	--	--	33	36.	64	33.
14	--	--	13	31.	1	100.	38	21.	52	25.
15	--	--	5	40.	--	--	32	16.	37	19.
16	--	--	2	50.	--	--	9	33.	11	36.
17	--	--	--	--	--	--	17	18.	17	18.
18	--	--	--	--	--	--	6	17.	6	17.
Total	2,423		537		983		246		4,189	

Davis Shoals Buoy (4DS#2). The 4DS#2 buoy succeeded the 4DS#1 buoy. It remained on station for 6 months from May 15, 1958, until November 10, 1958. The sample included 983 specimens of *A. aculeata.*

Channel Station. At a station about 44 miles northeast of Nantucket Shoals Lightship (41°03′ N. latitude; 68°45′ W. longitude) several bottom tows were made during the course of sea scallop investigations on September 16, 1959. From the dredged material 246 *A. aculeata* were picked from shells, stones, and debris.

Discussion: The larvae of *A. aculeata* pass through a pelagic stage in the upper waters during which time they are subject to variable currents and winds. Hence, they are apt to settle hither or yon in due time on the ocean floor. It is not surprising, then, to find samples made up of individuals that vary from one another widely. Verrill (Verrill and Smith, 1873) observing variation in this species thought it might possibly be a variety of the true *A. ephippium* which has a smooth surface. He was sure it was not *A. glabra [= A. simplex]* of our coast. Whiteaves (1901) remarked of the smooth form of eastern Canada as follows: "The little smooth form of this region that has been hitherto referred to *A. ephippium,* is regarded by Verrill as most probably a form of *A. aculeata.*" Jackson (1890) was able to separate the two species of *Anomia* in our area by means of prodissoconchal characteristics. He found that larval *A. aculeata* had a byssal notch both in the left and right valve, while larval *A. glabra* had a notch only in the right valve. By this means, we all are sure of which species he was referring when he stated, ". . . associated specimens are frequently wanting in the spinous character, although unquestionably belonging to the same species." Bousfield (1958, 1960) followed Whiteaves' lead (personal communication) in listing the smooth form as *A. ephippium.*

Two authors (Jackson, 1890; Foster, 1937) have remarked on the fact that the surface of *A. aculeata* may be smooth for a period of time before spines begin to form. Jackson was referring to the young growing for a brief period of time before any spines were produced; Foster was commenting on occasional large specimens on which the spines were represented only on the outer

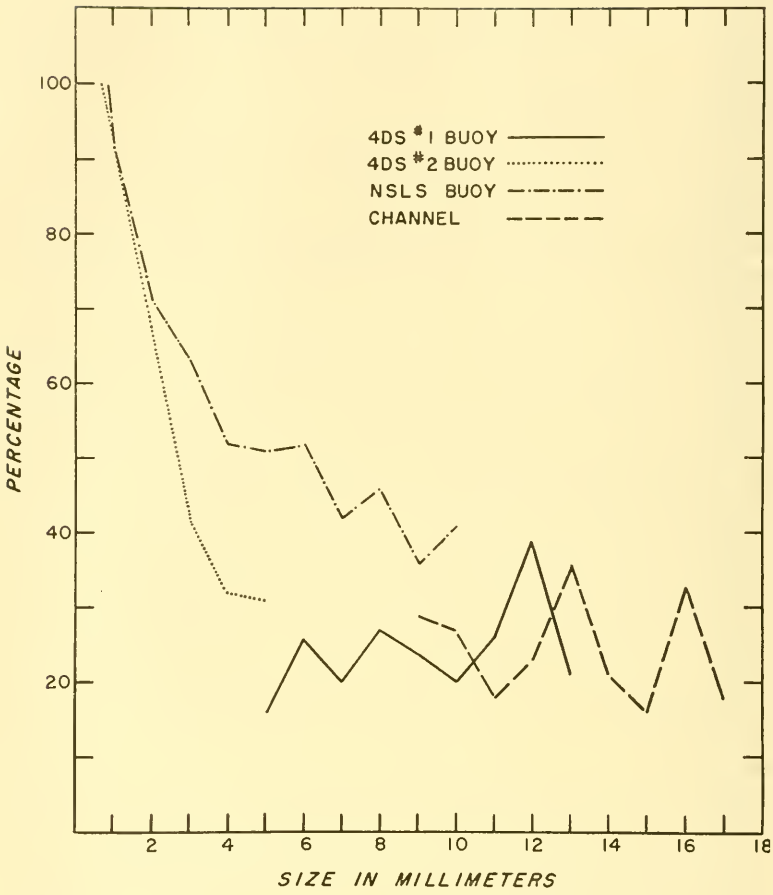
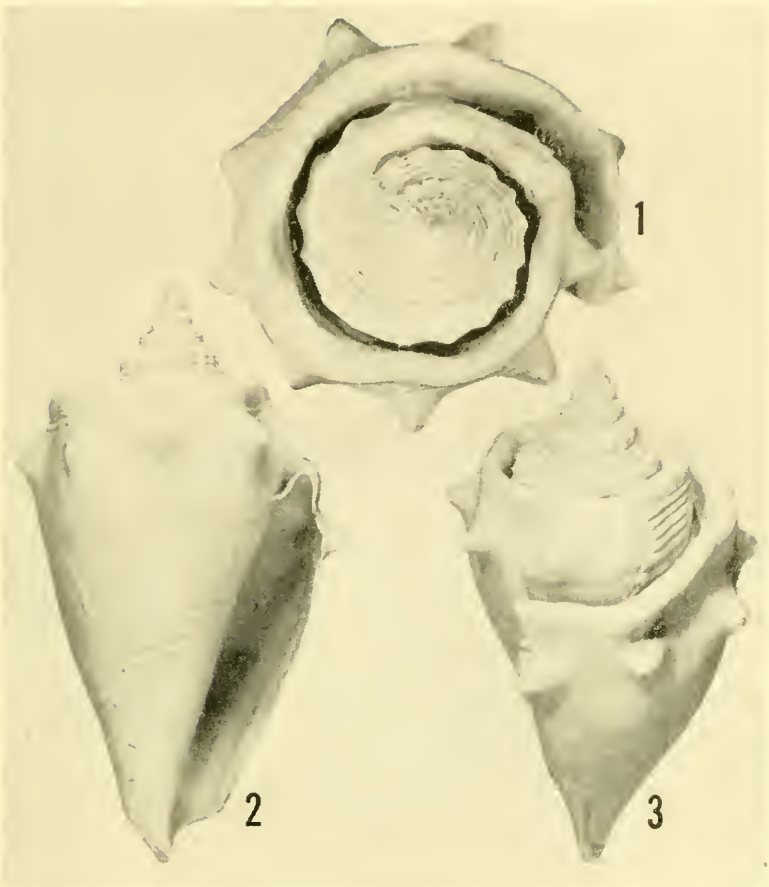


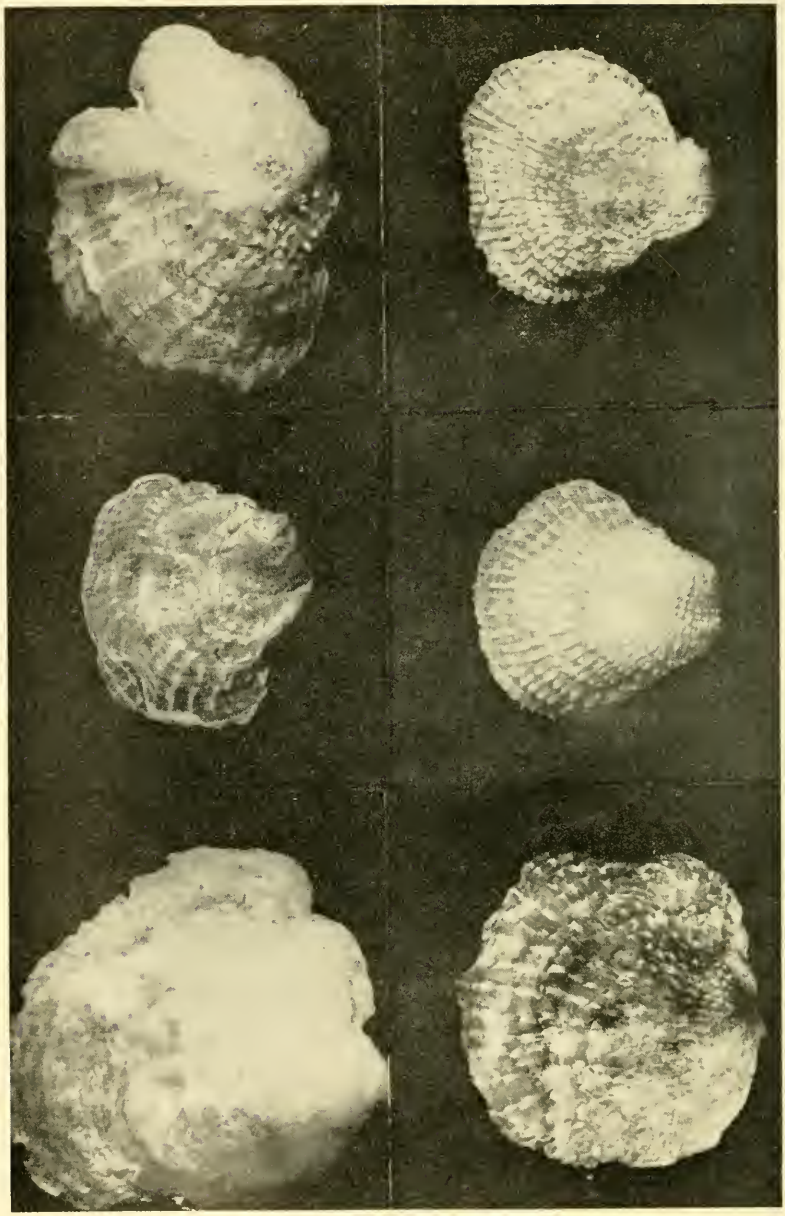
Fig. 1. Data from Table 1 plotted to show decrease in percentage of smooth-surfaced *Anomia aculeata* with increase in shell size.

edge of the shell. These miscellaneous facts can now be connected and a clear picture of variation presented by means of the data.

A. aculeata, in truth, is spineless for a brief period. The first signs of spines appear on occasional specimens at about 0.7 mm. By this time the shell has possibly tripled in height since setting. As can be seen on the graph in Figure 1, the percentage frequency of smooth individuals decreases rapidly at first and levels off at about 25 percent above 8 mm. In large spiny individuals



Malformed, carinate *Strombus (Strombus) pugilis alatus* Gmelin. Juvenile. Shell coated with MgO to show sculpture but not color pattern. Sanibel Island (?), Florida. American Museum of Natural History (no. 46068). Fig. 1. Apical view, ×1.37. Fig. 2. Apertural view. Fig. 3. Oblique view. Figs. 2-3 natural size.



Anomia aculeata Gmelin. Representative individuals arranged to show variation in shell sculpture.

one can easily trace back along the shell and see when spines were first laid down. Although this usually is found to be within the first few millimeters of growth, as reflected by the graph, it may be found on particular specimens at any size. Even a specimen of almost maximum size may finally express potential to produce spines.

It should be pointed out, in regard to using material mostly from buoys for this study, that the environment on the buoy is probably more uniform than on the bottom. However, the small amount of data from the bottom collections fits in well with the data from buoy samples. This tends to confirm the possibility that variation in surface sculpture in *A. aculeata* might be a genetic rather than an environmentally induced phenomenon.

Conclusion and Summary

1. Surface sculpture in the shell of *Anomia aculeata* varies considerably depending, in part, on size (or age). The surface may be smooth or, to a highly variable degree, spinose. A long series of similarly-sized specimens from single buoy samples can be formed in which graded variability in surface structure is shown easily. Therefore, in keeping with the usual procedures in taxonomy, no distinction should be shown the extreme variants.

2. All early post-larval *A. aculeata* have smooth surfaces and, although a percentage may remain smooth throughout life, many start early to put on spines, the percentage of spiny individuals increasing with shell size.

3. The fact that smoothness is always expressed in the early dissoconch shell implies that spinosity is a natural later development. The early smooth shell undoubtedly represents the generalized or ancestral form. The generalized form found along the western Atlantic coast is *A. simplex*, or along the European coast, *A. ephippium* (type species of *Anomia*). Spinosity, a divergence from the generalized, may be considered a derivative.

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ENHANCEMENT OF LATENT SHELL FLUORESCENCE BY GLYCERINE

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At the close of a recent period of collecting and experimenting, an interesting observation was made pertaining to the fluorescence of shells (1) which is deemed worthy of preliminary publication at this time.

All specimens were obtained at and below (using scuba) the "low tide line", Northwest Harbor, Deer Isle, Maine, August 28-29, 1961. The ultraviolet light used was one originally developed for underwater work and littoral exploration (2) emission being from a BLB lamp (approximately 3500 to 4000 angstroms).

While attempting to ascertain the suitability of glycerine as a preservative for the color and normal fluorescence of "coralline algae" (3), a small "limpet" adhering to one specimen was inadvertently coated with the glycerine, whereupon (in the dark) under the ultraviolet light the limpet shell burst into a strong, glowing, deep red fluorescence.

Fifteen living specimens of *Acmaea testudinalis testudinalis* (Müller) (limpets) were subsequently either coated with or immersed in glycerine. In every case a deep red fluorescence resulted over the entire shell while under the glycerine. Prior to treatment these specimens had no apparent visible red fluorescence.

Unfortunately time did not permit an examination of the effect of glycerine on the fluorescent areas (feeding?, homing?) surrounding such limpets when they are found living on "bare" rocks — an observation made by the writer some years ago (unpublished).

Twenty-seven living specimens of *Littorina littorea* (Linné)

(the common periwinkle) were treated with glycerine. In all cases, a similar deep red shell fluorescence of considerable intensity resulted, particularly strong in small specimens. Location of the area of maximum shell fluorescence was somewhat variable, appearing to have a tendency to localize in areas in the proximity of the apex. Fifteen specimens kept immersed in glycerine appear to have retained their red fluorescence unchanged for two months.

In the case of the periwinkles, the writer has felt for some years that occasionally some sort of dark red shell fluorescence could be observed but it was so illusive and ephemeral that such observations could be considered at best as highly questionable; however, it has led the writer to refer to the phenomena as "enhancement" of fluorescence, rather than, say, "inducement."

Vigorous scraping with a knife blade of both limpet and periwinkle shells subjected to the above glycerine treatment resulted in no apparent diminution of shell fluorescence until the shells were deeply abraded — suggesting that the phenomena is not due to a superficial shell coating.

Three small, living specimens of *Buccinum undatum* Linné (the common welk) coated or immersed in glycerine showed no such shell fluorescence.

A small specimen of *Clanculus puniceus* from the writer's collection of fluorescent shells showed no particular enhancement of its normal brilliant rose fluorescence.

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REPRODUCTION OF OLIVELLA MUTICA[1]

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Olivella mutica (Say) occurs commonly in warm, shallow

[1] Contribution no. 171 from the Oceanographic Institute, Florida State University, Tallahassee, Florida.

waters from North Carolina to Texas, and in the West Indies (Abbott, 1954). However, little appears to be known about its general biology. The following observations are primarily concerned with the external form of the egg capsule, length of the developmental period, and duration of the spawning season. Some data are also presented on the nature of the occupied habitat and population density. This study was made possible through use of the facilities of the Alligator Harbor Marine Laboratory of Florida State University, in Franklin County, Florida. Menzel (1956) has cited *O. mutica* as a common snail in the immediate region. *Olivellas* were collected from the south end of a sandbar lying across the mouth of Alligator Harbor. Extensive portions of this bar become exposed at most low tides.

Thirty-two snail egg capsules of similar appearance but of unknown parentage were collected, primarily from the valves of a brachiopod which occurs commonly on the bar. All but 7 of these embryos were reared successfully in filtered sea water, and many of them were then maintained until they were sufficiently large to be identified. Most were identified from Abbott (1954) and Olsson's monograph (1956) as *O. mutica*. However, one *O. pusilla* (Marrat) which is also present at Alligator Harbor, was subsequently discovered included with the specimens of *O. mutica*. Because, unfortunately, laboratory-raised and field-collected specimens were mixed, I do not know whether all the eggs were *O. mutica*, or whether a few might have been *O. pusilla*. This confusion of two very similar species will not affect those conclusions based on egg capsules in which *O. mutica* is known to have predominated. However, no distinction was drawn between these two olivellas in the field and thus the density and habitat information includes both species.

Adult snails were noted from September, 1959, to August, 1960, indicating year-round occupancy of the intertidal portions of the sandbar's southern end. The bottom sediment here is predominately a mixture of fine-grained quartz sand with an average diameter of 0.125 to 0.250 mm., and a few shells or shell fragments. The silt and clay fractions of the sediment are minimal, and little decaying organic matter has accumulated. The marine grass *Diplanthera wrightii* (Ascherson), occurring in patches, has consolidated portions of the bottom sediment but has not changed the physical characteristics of the substratum

appreciably. *Olivellas* were collected from both consolidated and unconsolidated sandy sediment, with the maximum density of 178 snails per square meter in the latter. Snails of this genus were not found in samples from soft bottom areas overlain by quantities of organic material.

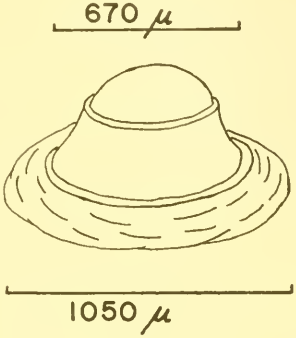

Fig. 1. Usual egg capsule of *Olivella mutica*.

The encapsulate eggs of *O. mutica* (Figure 1) are laid separately, one ovum per capsule, with no trace of nurse eggs, and are attached to any solid object that protrudes above the surface of the sand. The general characteristics of the egg and the site of oviposition are thus similar to those described by Marcus and Marcus (1959) for *O. verreauxii* (Ducros). The base of the egg capsule of *O. mutica* is roughly circular and 1.0 to 1.1 mm. in diameter. From this base rises a smooth, spherical, transparent dome about 670 microns in diameter. Near the top a distinct ridge indicates the line along which the capsule lid separates when the young snail escapes. In general form the capsules appear indistinguishable from those figured by Perry and Schwengel (1955) for *O. pusilla*. In contrast, the egg capsule of *O. verreauxii* (Marcus and Marcus, 1959), though entirely similar in gross shape, can readily be distinguished by the surface sculpturings — fine, raised, parallel lines.

The majority of the eggs of *O. mutica* were found attached to the anterior end of the valves of the inarticulate brachiopod, *Glottidia pyramidata* (Stimpson), with from 1 to 5 capsules per brachiopod. Freshly-deposited eggs or developing embryos were obtained on 25 March and 8 April, 1960, when the water temperature ranged from 16° to 20° C. The maximum developmental

period, based on laboratory-reared eggs, was 19 or 20 days for both collections. The cleavage and veliger stages are spent in the capsule, and upon hatching the capsule lid is broken off and a young snail, 750 microns in length crawls away. On the other hand, Marcus and Marcus (1959) have shown that *O. verreauxii* hatches as a veliger after 8-9 days.

Large samples of the brachiopod were also closely scrutinized on 26 February, 10 and 12 March, 22 and 23 April, and 3, 8, 25, 26, and 28 May; they were devoid of *Olivella* egg cases. The first egg to hatch in the laboratory did so on 6 April. If one extrapolates back 20 days, the suggested period of embryonic development, the initial spawning took place about 17 March. Egg-laying appears to have ceased sometime between 8 and 22 April. These data suggest that *O. mutica* spawns for approximately one month during the spring, and that egg-laying is closely limited to this period. No information is available on spawning in the fall, or latitudinal variations in the duration of egg-laying.

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PUERTO RICAN OLEACINOIDS

By H. BURRINGTON BAKER

The symbols used for Puerto Rican localities were explained recently, 1961 (1).

Yunquea denselirata H. B. Baker. Only known from type locality (Er3); on last whorl of type (only dry) shell, "very fine" growth threads average 11 microns from crest to crest, which means 91 per mm., and that the "very slightly stronger" ones run 13 to 15 per mm. *Y. monteplatonis* (Pilsbry) has similar threads.

Odontosagda sp. *"Yunquea denselirata"* van der Schalie, 1948:

71, pl. 6, fig. 5. Probably an unnamed species, from about 3 km. south of Aguas Buenas.

The anatomy of *Odontosagda* is unknown. Although its shell has internal lamellae (like some Sagdinae), in general form and size, it does resemble more closely that in *Yunquea* (Yunqueinae).

Hyalosagda (Microsagda) subaquila (Shuttleworth). Among dead leaves in disturbed places, En, Jn, Pn, Pr1 (2500 ft.), Wn, Wr2, Ws, Ww2; mainly lowlands. Foot light near sole but almost black above, with lighter middorsal stripe and triangle between ommatophores, which are very dark; eyes light with dark centers.

H. (M.) subaquila, var. a. Ps1-3; shell more depressed, with larger umbilicus (about 1/5 major diameter).

H. (Lacteoluna) selenina (Gould). Probably distributed by commerce; Es2, Jn, Pn, Pr2-6, Wn, Wr, Ws, 0-3400 ft., but not found in Luquillo forests.

H. (Aerotrochus?) krugiana (Martens). Size (1877:346): 3.5 by 171 (6 mm.) with 5 whorls, subangulate, narrowly umbilicate. Caguana, west of Utuado.

Martens compared the last species to the Cuban *Helix turbiniformis* Pfeiffer, which at the time was confused with type species of *Aerotrochus,* the Jamaican *Hyalosagda subpyramidalis* (C. B. Adams); the last is a higher, but angulate shell, which lives on trunks of trees. These 3 Puerto Rican species belong in the subgenus (or genus?) *Lacteoluna; Hyalosagda* (s. s.) and *Stauroglypta* appear to be mainly Jamaican.

Aquebana (s. s.) velutina (Lamarck). Living animals very rare, under rocks, 5-6 inches below surface (Jn1) and under dead leaves between limestone ledges (En1) during and at end of drouth, but dead shells numerous (Jn2) which may indicate that it has periods of abundance. Fresh shells with greenish tinge. To 1940c:59, is added: foot pale, with chrome spots, obscured by chalky ones.

Platysuccinea portoricensis (Shuttleworth). Terrestrial, under upper layer of dead leaves, especially in ruderal places; Er, Pr, Wr, 1500-4000 ft. Fresh shells, with adherent dirt except in columellar region, greenish corneous on El Yunque and often with very low spires, but often more hyaline with higher spires in Cordillera Central. Animal (added to 1940c:61) rather sluggish; side of foot very warty, ochraceous to brown, darker in wrinkles, dorsad and on ommatophores; mantle collar not overlapping peristome but with umbilical lobe over columellar area; sole dark slate, only trizonal, with numerous rapid waves in middle zone.

P. portoricensis, var. a. Under rocks, En1; also empty shell from Pn1; less than 200 ft. Shells much smaller, more hyaline and

with higher spires, but not distinguishable from young ones from Cordillera Central; also quite similar in form to *"Simpulopsis" aenea* Pfeiffer, 1861, as figured by Fischer & Crosse, 1877, Miss. Mex. Moll. *1*:pl. 24, figs. 12; *"S." cumingi* Pfr., P. Z. S., 1861:pl. 3, fig. 2, from Mexico, looks like typical *P. portoricensis* (some El Yunque shells even larger); and ruderal snails do get around.

Varicella (Vagavarix) portoricensis (Pfeiffer). Terrestrial; En, Es, Jn, Pn, Pr3,6, Wn, Wr2,3, Ws, 0-3000 ft., but not found in Luquillo Mts.

V. (Vagavarix) calderoni H. B. Baker. On ground; Pr6, Wr2, 2000-3000 ft., Cordillera Central.

V. (Vagavarix) sulculosa (Shuttleworth). Terrestrial; En, Es, Jn, Pn, Pr1,5,6, Ps2,3, Wn, Wr, Ww, 0-4000 ft., but not found in Luquillo Mts. Larger lots intergrade completely with smoother form *terebraeformis* (Sh.), which has more widely and irregularly spaced growth striae; mostly size of *sulculosa* but one (Ps2) 12.1 mm. long with 8.2 whorls.

V. (Vagavarix) sporadica H. B. Baker. On ground; Es3,4, Er2, 200-2500 ft., only found in eastern Puerto Rico.

Oleacina (Laevaricella) interrupta (Shuttleworth). Usually subarboreal, but also seen alive under leaves at base of trees; Er2, Pr2,3, Wr2,3, 2000-3400 ft., ranging from Luquillo Mts. to western Cordillera Central. Animal (1941b:29) seen attacking *Nenia;* lateral zones of foot narrow.

Oleacina (Boriquena) glabra (Pfeiffer, 1846). Terrestrial, Er2-5, above 2000 ft. in Luquillo Mts.

O. (B.) playa (H. B. Baker). On ground; En, Es3, Jn, Pn, Wn, Ws, lowlands, 0-800 ft. This "large, elongate, smooth species common to Puerto Rico" first noticed and called "gracilior" by Shuttleworth, 1854:51; all I did (1940a) was to prove it a distinct species and name his "var. beta" in *Varicella;* if his descriptive term be considered a trinomial, it would be preoccupied in neither *Glandina* nor *Oleacina.*

Although the animal of *Oleacina* s. s. is still unknown, *Boriquena* (possibly only a section) and *Laevaricella* (a very distinct subgenus) now are made congeneric with it, because of the close resemblance in the embryonic shells of *Oleacina, Boriquena* and *Varicella* s.s., which was pointed out by Pilsbry, 1907 (12a): 127, and because the differences in shell form between *O. voluta* (Gmelin) and *O. (voluta* var.?) *flexuosa* (Pfr.) from Haiti so closely parallel those between the Puerto Rican *O. glabra* and *O. playa.* In 1956:133, 135, after vacillating in 1941d and 1943c, the almost strictly Antillean Oleacinidae (+ Varicellarum), with 1 Cuban species in Florida, were separated from the Spiraxidae (including Streptosylinae and Euglandininae), which are most

differentiated on the mainland, but have invaded Jamaica (Spiraxinae) and other Antilles [Streptostylinae: *Salasiella (Laevoleacina & Flavoleacina), Streptostyla (Rectoleacina),* etc.].

These two families have almost nothing in common except their carnivorous habits and the correlated convergences in the radulae of their most specialized groups. Even in their radulae, the Spiraxidae almost intergrade with the Achatinidae (sens. lat.), which also have little epiphallic differentiation and sometimes (Ferussaciinae) have similar "heterurethrous'" pallial complexes. The changes in the radulae within *Varicella* (especially *Melaniella)* show that the convergences (uniformly aculeate teeth) have come from different sources, and the Oleacinidae have sigmurethrous pallial complexes and truly penial epiphalli, often with well developed verges, much more like those in the Sagdidae. The unroofing of the adrectal limb of the ureter, which is paralleled in both the Oleacinidae and the bigger Spiraxidae (and in many other groups of geophiles) is found also in *Yunquea,* which has the most generalized radula in the oleacinoids. Incidentally as far as known, outside the small species of *Hojeda,* and the *ruderal Hyalosagda selenina* and (possibly) *Platysuccinea,* the Sagdidae also seem to be restricted to the Antilles.

Additional references (see 1962)

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RADULAE OF NORTH AMERICAN ANCYLID SNAILS II. SUBFAMILY NEOPLANORBINAE[1]

By PAUL F. BASCH

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The subfamily Neoplanorbinae was established by Hannibal (1912) to accommodate 5 species in two unusual genera of freshwater mollusks. These species demonstrate an extreme in endemism, all known specimens having been collected from the lower Coosa River bordering Coosa, Chilton, and Elmore counties in central Alabama. As far as I am aware, only two men, H. H. Smith and A. A. Hinkley, have ever seen these animals alive, and it is unlikely that living specimens will be seen by anyone else.

The first mention of these snails was by Hinkley in 1904, who listed both *"Planorbis tantillus* Pilsbry" and an undescribed

[1] Supported by grant G-14125 from the National Science Foundation.

form, "*N. g., n. sp.*" among a group of Alabama shells collected the previous year. Pilsbry (1906) recognized these shells as ". . . quite unlike any fresh-water snails hitherto known in this country, having affinities with the Ancylidae." He established two new genera for them, describing *Amphigyra alabamensis* and *Neoplanorbis tantillus* as new species. Two years later, Walker (1908) named 3 additional species of *Neoplanorbis: N. carinatus, N. umbilicatus,* and *N. smithii,* and these have remained, without change or addition, to the present.

In 1914 Lay Dam, the first of a series of major hydroelectric power installations, was completed across the Coosa River between Coosa and Chilton counties, 13 miles east of Clanton, Alabama. This dam imponds an area of 6,000 acres, with a backwater extending to a point 13 miles below Childersburg (Pierce, 1955). Sixteen miles downstream Mitchell Dam was completed in 1923, with 5,800 acres of backwater extending to Lay Dam. In 1929, Jordan Dam was built 8 miles north of Wetumpka, Elmore County. This dam supports a lake of 4,900 acres, extending about 18 miles upstream to Mitchell Dam. The large lakes formed by these dams, which provided power and recreational facilities for the people of central Alabama, also destroyed the habitats (and presumably caused the extinction) of all known species of Neoplanorbinae. These tiny mollusks lived on stones in the swift current of the Coosa (See Goodrich, 1944), in localities now covered by many feet of impounded lake water. An attempt in June, 1959, by the author and Dr. John B. Burch to find living specimens in the Coosa was not successful (Basch, 1959).

Through the kindness of Dr. Henry van der Schalie of the University of Michigan Museum of Zoology I have been given access to the specimens of Neoplanorbinae in his care, with permission to extract and prepare radulae from a sample of the specimens. The radulae were extracted and mounted using techniques outlined in a previous paper (Basch, 1961). A study of these radulae was undertaken in an attempt to learn more about the systematic position of the Neoplanorbinae by comparison of their radulae with other groups of Bosommatophora.

In *Neoplanorbis,* the shell is planorboid and extremely similar in conformation and dimensions with shells of *Micromenetus* of the family Planorbidae. Since *Menetus (Micro-*

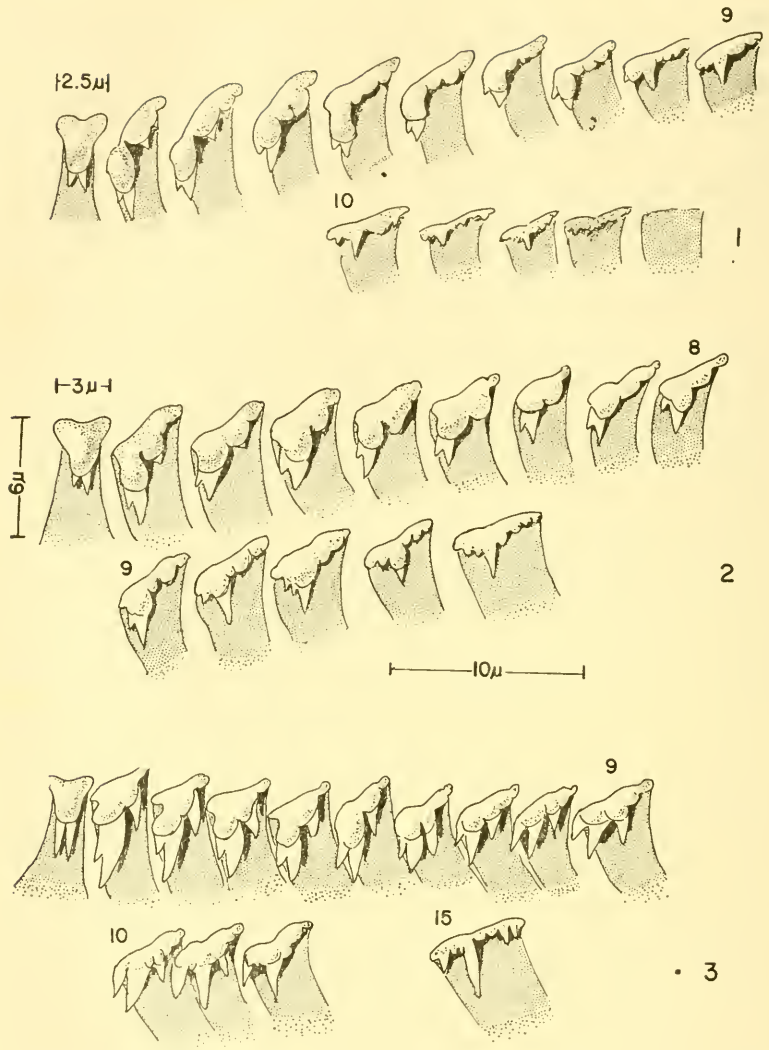
menetus) alabamensis is known from the state, I considered that possibly *Neoplanorbis* represented a special group of *Menetus*-like planorbid snails. Ecologically, *Menetus* is an inhabitant of quiet, plant-filled pools in a situation vastly different from the rocky rapids of the old Coosa River. Shells and radulae of *Micromenetus* are illustrated by F. C. Baker (1945).

The following radulae have been prepared (UMMZ numbers):

#102672—*N. tantillus,* 2 specimens.
#102664—*N. carinatus,* 2 specimens.
#102671—*N. smithii,* 2 specimens.

The species studied were all similar in radular characters. *Neoplanorbis tantillus, carinatus,* and *umbilicatus* are obviously closely related on the basis of shell similarities and may in fact represent a single variable species. The radulae of *N. tantillus* and *N. carinatus* are indistinguishable (it was not possible to obtain a suitable specimen of *N. umbilicatus). Neoplanorbis smithii,* whose shell is easily differentiated from the other three by its lack of spiral sculpture, has a radula differing in minor characters, particularly the angle formed by the medial surface of the lateral teeth with the longitudinal axis of the ribbon. In all three species of *Neoplanorbis* the radular formula is 17-1-17, with the inner cusp of the laterals long and dagger-like, bearing a small accessory cusp on its medial surface. The marginal teeth are characterized by an increasingly rectilinear upper edge and a prominent needle-like cusp located just medial to the center of the tooth (Page 148, Figs. 1 and 2). The extreme smallness of these teeth must be pointed out, for some of the finer features lie beyond the resolving power of a light microscope. The optical equipment used in this study consisted of a Leitz triocular Labolux microscope with a 100X N. A. 1.30 oil immersion objective and paired 20X oculars. An internal prism factor of 1.25X provided a final magnification of 2500X. Even at this extreme magnification, some details were not readily distinguishable in the bacteria-sized teeth.

The radula of *Amphigyra* is strongly bicuspid (cf. Pilsbry, 1906) and similar to that of *Neoplanorbis.* The formula is 18-1-18, and lateral teeth 7 to 11 resemble planorbid and some ancylid laterals rather closely (Page 148, Fig. 3), perhaps establishing a point of homology. Two radulae were prepared from



Radulae of Neoplanorbinae. Fig. 1, *N. carinatus Walker;* Fig. 2, *N. smithii* Walker; Fig. 3, *Amphigyra alabamensis* Pilsbry.

specimens in UMMZ lot #102677.

Judging by the radula, apparently *Amphigyra* and *Neoplanorbis* are closely related to each other, but they have diverged considerably from other groups of Basommatophora. With

a dearth of anatomical data concerning the Neoplanorbinae, its position within the Ancylidae is not firmly supported by radular structure alone, but no other evident relationships are revealed.

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GONAD DEVELOPMENT AND SPAWNING OF BRACHIDONTES RECURVUS IN CHESAPEAKE BAY

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The hooked or curved mussel, *Brachidontes recurvus* (Rafinesque) of the family Mytilidae, occurs in large numbers on oyster bars in the upper Chesapeake Bay and its tributaries. This species is an important fouling organism on oyster bars and affects the growth habits of the oyster. It was reported by Frey (1946) as forming much of the cultch on oyster bars in the Potomac River where most of the marketable oysters were completely covered with mussels. As a result, the oysters were misshapen from growing among the mussels. Beaven (1947) states that this species is most abundant on bars of the upper portion of the Bay and its tributaries where the salinity is low.

Under the name *Mytilus recurvus,* this species has been reported (Nelson, 1928a) as occurring along the New Jersey coast. Chestnut (1949) noted the appearance of the curved mussel in North Carolina. Engle (1945) observed that the hooked mussel, *Mytilus hamatus* Say, was present on oyster bars in Alabama,

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and later (1948) the same investigator reported its presence on bars in Mississippi and Louisiana. According to Abbott (1954) the geographic range of *Brachidontes recurvus* is Cape Cod to the West Indies.

Despite the wide distribution of this species and its importance as a fouling organism on oyster bars, a survey of the literature reveals that with the exception of the observations on distribution previously mentioned, little information is available concerning its biology. This situation is in sharp contrast to that existing in regard to other mussels, such as *Mytilus edulis* Linné; *Mytilus californianus* Conrad; *Modiolus demissus* (Dillwyn) ; and *Modiolus modiolus* (Linné), where considerable data are available on numerous aspects of the biology of the species.

The investigation reported here was part of a cooperative program between the Department of Zoology of the University of Maryland and the Shellfisheries Investigations of the United States Fish and Wildlife Service, located at Annapolis, Maryland. Appreciation is expressed to Dr. Robert A. Littleford for his suggestions and criticisms; and to Mr. James B. Engle and Staff of the Fish and Wildlife Service for collection of materials and for data on temperature and salinity.

Procedure: Specimens of *B. recurvus* used in this study were collected from Hackett's Bar, located on the western side of upper Chesapeake Bay and approximately two nautical miles north of the Severn River. This bar is ½ to ¾ of a mile offshore from Hackett Point, in water varying in depth from 2 to 35 feet. Samples were taken at two week intervals from January 16, 1950 through April 16, 1951, except when prevented by weather conditions or mechanical difficulties with the boat. All the mussels were collected with a standard oyster dredge from the same general location on the bar and at a depth of 16 feet.

With the shell closed and the specimen held in a lateral position (Newcombe and Kessler 1936), shell dimensions were measured to the nearest tenth, using a sliding vernier caliper calibrated in millimeters. The dimensions used are defined as follows: length, the greatest distance between the anterior and posterior ends of the shell; width, the greatest distance between the dorsal and ventral edges; and thickness, the greatest distance between the right and left valves. The term *height* is commonly

used in place of *thickness* as a more meaningful designation.

Specimens of the entire size range were selected from each collection for microscopic study. The individuals were fixed within the shell by severing the posterior muscles and then dropping the entire animal into Bouin's alcoholic fixative (Galigher, 1934). Other fixatives were tried but Bouin's proved most satisfactory. After fixation for several days, they were removed from the shell, washed in 70% alcohol and then stored in 80% alcohol. They were dehydrated in alcohol and xylol, embedded in Tissue Mat, sectioned at 10 micra, stained with either Harris's hematoxylin and eosin or Mallory's triple stain, and mounted in balsam.

Plankton samples were collected simultaneously with the collection of mussels by pumping 100 liters of water from just above the bar through a No. 20 silk plankton net. Each sample was concentrated to 100 ml. and preserved with formalin. Examination of these samples to determine the presence or absence of mussel larvae was made with a Sedgewick-Rafter Cell (Littleford, Newcombe, and Shepherd, 1940).

Observations. The gross microscopic morphology of the curved mussel is identical with that of *Mytilus edulis* as described by Field (1922). However, the alimentary tract is surrounded by the visceral mass which contains the other organ systems of the animal. Immediately surrounding the stomach and intestine is the so-called liver, or digestive diverticula. The latter structure also extends into the mesosoma, which is an elongate, ventral extension of the visceral mass, except during the period of gonad development, when the mesosoma is filled with the gonad tissue.

The gonadal tissue of *B. recurvus* consists of a series of ducts and canals, lined with germinal epithelium, which end in pockets or follicles. The mature tissue occupies almost the entire mantle (Plate 15, fig. 4) and the mesosoma to the edge of the foot and penetrates into the digestive diverticula, where it is found adjacent to the so-called liver canals, the stomach, and the direct and recurrent intestine. Apparently the early gonad development begins in the mantle and then spreads into the mesosoma. The vesicular tissue which fills in between the follicles is replaced by the gonad tissue as it matures. Thus, when the sex cells are mature, nearly the entire structure of the organism is devoted to

reproduction. As sexual maturity approaches, the mantle and mesosoma become either a bright yellow or a stippled brown in color.

The curved mussel is dioecious, and of the 896 specimens examined, there was no indication of the existence of hermaphroditism or alternation of sex. The gonads of both male and female show parallel development in time and in the position of the gonads. From those studied, the sex ratio apparently is evenly distributed. The reproductive potential of these mussels is determined by their size rather than by their age. Studies were made of those forms which were as small as 20 mm. in length, and their gonad tissue had the same appearance as that of the larger specimens. Presumably they produce as many reproductive cells as their anatomical structure will allow. This also leads to the conclusion that sexual maturity occurs the summer following setting, regardless of size of the mussel.

Seasonal Development in the Male. The male follicles vary a great deal in size, depending upon whether the immature or mature condition is observed. From January until mid-April, the follicles are found in the mantle, and to a lesser degree, in the mesosoma. They appear at this time to be loosely filled with cells, but by mid-April they become more dense in appearance and they take a deeper and a darker stain (Plate 15, fig. 1). As they mature, the follicles become filled with spermatozoa which radiate from the periphery of the follicle toward the center (Plate 15, fig 2). These cells appear as small oval or spherical bodies which are packed too closely together for their detailed structure to be clearly visible. They mature by June and remain mature until October. Observation on the density of the sex products in the follicles leads one to believe that spawning may occur from the mantle first, then proceed from the mesosoma. However, the appearance indicates that the animal could very well spawn simultaneously from both areas. Spawning from each follicle extends over a considerable period of time so that some follicles do not have the appearance of being spent, while others are mature. As the follicles mature, there are light, radiating areas, which under increased magnification show that the cells adjacent to these areas are concentrated in short rods, apparently similar to the condition observed in *Mytilus edulis* (Field, 1922).

While the follicle increase in size and maturity, the supportive vesicular tissue surrounding them gradually disappears almost completely. After spawning, the supportive tissue again appears, filling the spaces between the spent follicles.

Seasonal Development in the Female. The immature follicles of the female are separated by vesicular connective tissue and vary in size. By the first week in May, the follicles are lined with small cells containing nuclei which with hematoxylin and eosin stain a dark blue. By the third week in May, the cells have increased in size so that the prominent nucleoli can be seen, but the cells are still immature. By mid-June, the mantle and the mesosoma are occupied by follicles which are filled with mature and immature eggs (Plate 15, fig. 3). Some of the vesicular supportive tissue is present, but has decreased considerably or disappeared as the eggs approach maturity. The eggs vary a great deal in size and the nucleoli are large and prominent (Plate 15, fig. 3). When the eggs mature, they break from the follicle and are moved along by ciliated ducts. The eggs are not considered mature until they break free. As is the case in the male, the female gonad tissue penetrates into the digestive diverticula and is in close proximity to the liver canals. (Plate 15, fig. 3). The condition of the gonad from July to October is similar to that in June. After October, however, the ova are not as numerous and some retain the same appearance as those of June.

On July 3, the small eggs appeared in the mantle and the larger ones in the mesosoma which contained many follicles. In one specimen from the September group, one lobe of the mantle contained only a few eggs, while the other lobe and the mesosoma were dense with them. Although the condition of the maturity of the ova is such that the entire gonad tissue is subject to spawning at the same time, the intensity of spawning and the time of spawning of these different areas depends upon the individual.

Mature eggs are present in December, but show evidence of degeneration or death, as shown by the condition of the nucleus, the absence of nucleoli, and the general appearance of the cytoplasm. While the destruction of the gonadal tissue appears evident, there is no similarity to the comparable mechanism of resorption noted in some pelecypods by Loosanoff and Davis (1951).

The development of the gonads indicates that the state of sexual maturity exists from June through October. Release of the sex products occurs over a relatively long period of time, from early June through October, and in some cases, through November. Individual follicles develop independently of each other in both sexes. In other words, the gonads do not reach a high peak of maturity and immediately spawn out.

Seasonal Distribution of the Larvae. Plankton samples collected from January 16, 1950, through April 16, 1951, were examined to determine the presence, relative abundance, and stages of development of the larval forms of *B. recurvus.*

Since the rate of development of the larval stages shows considerable variation, in part, at least, because of the protracted spawning period, I decided to divide the forms present into three groups: pre-hinge stage, hinge stage, and post-hinge stage. The hinge stage was defined as "the straight-hinge-line embryonic shell" (Field 1922), between the circular immature larval stage and the triangular ovate form of the mature larva. In the area of Hackett's Bar, the larval stages of this species could be confused only with the larval stages of *Congeria leucophaeta, Crassostrea virginica,* or possibly with *Tagelus plebeius* and *Mya arenaria.* However, as is pointed out by Sullivan (1948), careful examination will show numerous diagnostic differences between the mussel larvae and other lamellibranchs. Therefore, the larval stages of different groups may be easily separated from each other, although some confusion might possibly arise in regard to the larvae of *Brachidontes recurvus* and that of *Congeria leucophaeta.* However, considering the rare occurrence of the latter form on Hackett's Bar, such confusion should not invalidate the data.

The results of the observations on larval distribution are presented in Table I. The relative abundance of the various larvae is expressed as present, common abundant, and very abundant, rather than by using some numerical statement. I felt that such an expression of results had more validity than an exact numerical expression, since the method of collection was not subject to exact quantitative analysis (Littleford, Newcombe, and Shepherd, 1940).

Larvae appeared in the plankton for the first time on June 5,

TABLE I

SEASONAL OCCURRENCE OF LARVAE OF BRACHIDONTES RECURVUS IN PLANKTON SAMPLES

Date	Pre-hinge	Hinge	Post-hinge
June 5	Present	Present	Absent
June 19	Common	Common	Present
July 3	Common	Common	Common
July 17	Absent	Present	Present
July 31	Abundant	Present	Absent
August 14	Common	Common	Absent
August 28	Abundant	Abundant	Abundant
Sept. 11	Very Abundant	Very Abundant	Very Abundant
Sept. 25	Common	Present	Common
October 9	Present	Absent	Common
October 25	Absent	Absent	Present
Nov. 13	Present	Common	Common
Nov. 27	Absent	Absent	Present
Dec. 11	Absent	Absent	Present

1950 when pre-hinge and hinge forms were observed in the samples. By the middle of June, the pre-hinge and hinge stages had quadrupled in number over the earlier part of the month. The post-hinge stage was observed for the first time on June 19, 1950. During July and August there was, generally speaking, a continued rise in abundance of the larval stages. However, the pre-hinge stage was not found on July 17, 1950 and the post-hinge stage was not observed in collections of July 31 and August 14. All three stages were present in large numbers in the collection of August 28, and the peak of their numerical abundance in

the plankton was observed on September 11, 1950.

Some idea of the relative seasonal abundance of the larval stages may be obtained from the fact that the number of pre-hinge larvae in June was 27.50% of the total number observed on September 11. Similarly, the number of the hinge larvae in June was 15.15% and the number of post-hinge was 0.54% of the total observed on September 11.

(To be concluded)

AUSTRALORBIS ALBICANS (PLANORBIDAE)

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This species was described by Pfeiffer (1839, p. 354), on the basis of the shell characters, as follows:

"43. Planorbis albicans Pfr.—Testa orbiculari, utrinque umbilicata, solidula, albicante vel pallide fulvicante, anfract. 3 teretibus; labro subincrassato albo; apertura subovata.—Diam. 2½, alt. 1'".—Dem Pl. albus (hispidus) am nächsten verwandt."

Clessin's description (1884, p. 119-120) is more detailed and extends the species range to other Antillean islands:

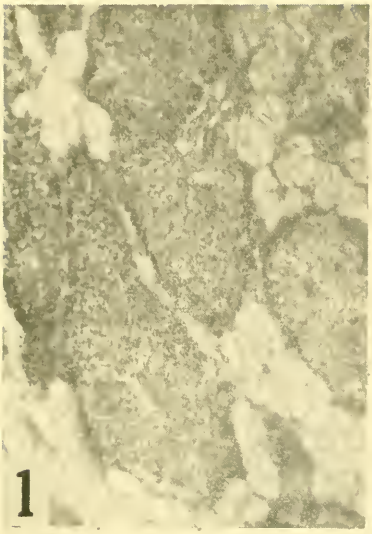
"87. *Planorbis albicans* Pfeiffer. Taf. 11. Fig. 14. T. depressa, utrinque centro profundissime immerso; subtiliter striatula; nitida, pallide-cornea; anfractus 4, rapide accrescentes, rotundati; superius valde convexi, sutura profundissima separati; inferius planulati, sutura paulo immersa disjuncti; ultimus penultimo paulo latior, aperturam versus descendens; apertura late-lunata, albo-labiata, valde obliqua; peristoma acutum, marginibus conjunctis. Diam. 5,5, alt. 1,8 Mm.

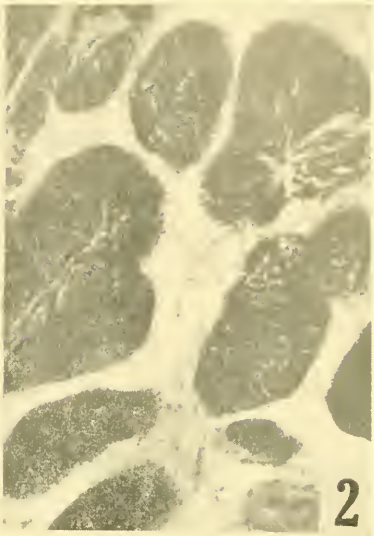
Planorbus albicans Pfeiffer Wiegm. Archiv I 1839 p. 354.

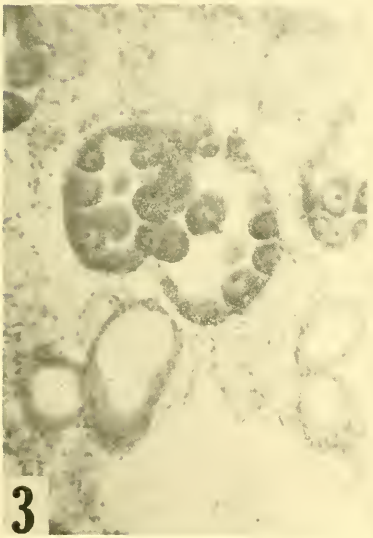
Planorbus albicans Reeve conch. Icon. XX f. 117. (?)

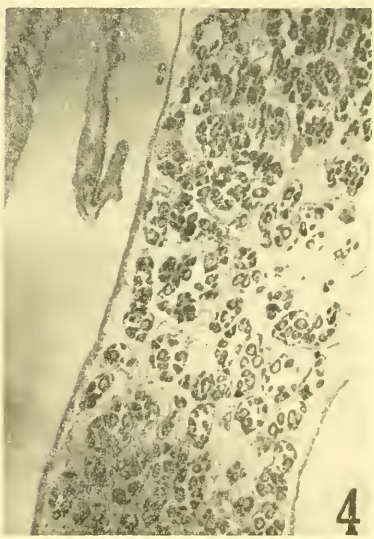
Gehäuse gedrückt, ober- und unterseits in de Mitte tief eigenesenkt, sehr fein gestreift, glänzend, hellhornfarben, Umgänge 4, rasch zunehmend, nach oben sehr gewölbt und durch eine sehr tiefe Naht getrennt; nach unten flacher und durch eine seichtere Naht verbunden; der letzte Umgang nur ½mal breiter als der vorletzte; gegen die Mündung etwas herabsteigend; Mündung breit-mondförmig, weissgelippt, sehr schief; Mundsaum scharf, mit verbundenen Rändern. Vaterland: Die

[1] Work made in cooperation with Instituto Oswaldo Cruz and Servico Especial de Saude Publica. Aided by the Conselho Nacional de Pesquisas of Brazil, which defrayed the expenses of a trip by the senior author to the type locality of *A. albicans* and also provided additional facilities for the study of the material collected there.









1, *Brachidontes recurvus* in mid-April. Immature follicles of the male gonad in the mantle. H. and E. stain. X200. 2, in June. Male follicles filled with spermatozoa. Note the radiation from the periphery of the follicle to the center. Gross section through the mesosoma. Mallory's Triple stain. X200. 3, in mid-June. Mature female follicles adjacent to the so-called liver canals in the digestive diverticula. H. and E. stain. X200. 4, in July. General view of cross section in region of the gills. Note the presence of mature and immature eggs and the prominence of the nucleoli. H. and E. stain. X50.

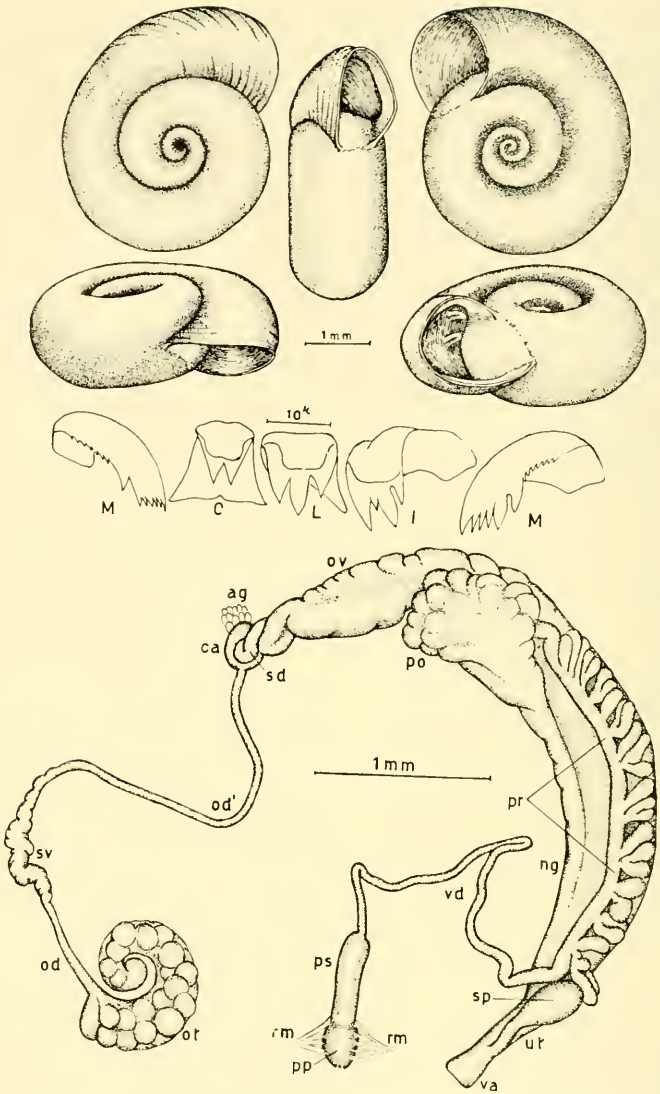


Fig. 1: Shell of *Australorbis albicans* from Laguna Somorostro, Havana. Fig. 2: Radula teeth of *Australorbis albicans* from Laguna La Canoa, Pinar del Rio (C = central, I = intermediate, L = lateral, M = marginal). Fig. 3: Genital organs of *Australorbis albicans* from Laguna La Canoa, Pinar del Rio (ag = fragment of albumen gland, ca = carrefour, ng = nidamental gland, od = proximal segment of ovispermiduct, od' = distal segment of ovispermiduct, ot = ovotestis, ov = oviduct, po = pouch of oviduct, pp = prepuce, pr = prostate gland, ps = penis sheath, rm = retractor muscles of penial complex, sd = spermiduct, sp = spermatheca, sv = seminal vesicle, ut = uterus, va = vagina, vd = vas deferens).

Antillen, Insel Cuba, bei Cardenas; Portorico, St. Thomas. (Coll. Dunker).

Die Art gehört zur Sect. Armigerus, welche durch im Innern der Umgänge angebrachte Zahne und Lamellen ausgeszeichnet ist.—Diese sitzen (meist zu 2 oder 3 an der Mündungswand, und zu 3 an der gegenüber liegenden Gaumenwand) und zwar in ziemlicher Entfernung von der Mündung, so dass sie gewöhnlich erst beim Zerstören des Gehäuses zu entdecken sind, wenn sie nicht durch die Umgänge durchscheinend von aussen an der weissen Farbe erkannt werden. Auf der Mündungswand steht gewöhnlich in de Mitte derselben ein grösserer stärkerer Zahn, dem nach unten gegen die Ecken ein kleinerer sich anreiht. Auf der Gaumenwand befindet sich in der Mitte eine lamellen— oder faltenartige Schmelzleiste, während zu beiden Seiten derselben in nahezu gleicher Entfernung von ihr und etwa in der Mitte des Raumes von der Mittelleiste bis zu den Anschlussecken zwei Höcker—oder zahnartige Schmelzstückchen angebracht sind.—Ueber den Zweck dieser Gehäuseverstarkungen fehlen bis jetzt noch Beobachtungen."

Among the planorbids collected by the senior author in Cuba, in December, 1956, there were specimens whose shell agreed, in shape and dimensions, to the two above transcribed descriptions, inclusive as to the apertural lamellae. Some of them, dissected for previous observation, proved young forms of a species anatomically undistinguishable from *Planorbis peregrinus* Orbigny, 1835. As then shown (Paraense and Deslandes, 1958b), the shape of the shell underwent a process of remodelling along with growth, with eventual resorption of the five lamellae.

A sample from Puerto Rico, sent us by Drs. F. F. Ferguson and Charles S. Richards in 1959, and regarded by them as *albicans,* was conchologically similar to the aforesaid Cuban material, but the specimens stopped growing when they reached about 7 mm. in diameter, developed permanent lamellae and showed remarkable anatomical differences.

Those facts led us to examine our remaining material, among which we found 11 specimens anatomically similar to the Puerto Rican ones. Of such specimens, 7 were collected at Laguna La Canoa (between Artemisa and Mangas, Candelaria, Province of Pinar del Rio), and 4 at Laguna Somorostro (Havana). The largest specimens were 5 mm. in shell diameter, and only two from La Canoa showed apertural lamellae.

Taking into account Pfeiffer's and Clessin's descriptions, and

the fact that we are dealing with topotypic specimens, we agree with Drs. Ferguson and Richards in considering this species as *Planorbis albicans.* Since the generic problem of the group to which it belongs was submitted to the International Commission on Zoological Nomenclature, the species is here placed in the genus *Australorbis,* according to the reasons presented by Paraense (1961).

The following description is based on the above-mentioned Cuban material, of which four shells and one dissected specimen were deposited in the collection of Instituto Oswaldo Cruz (No. 7907).

Description: The empty shell (Pl. 16, fig. 1), is yellow or amber, finely obliquely striate, has about 3½ whorls, and usually shows 6 internal lamellae deeply situated in the apertural region. The whorls widen rapidly, but at the region of the lamellae they stop expanding or even slightly decrease, and then rapidly widen toward the opening. The outer whorl shows various degrees of downward deflection at the apertural region. The upper (right) side is flattened and deeply umbilicate. It shows round smooth-walled whorls, of which the inner one is obscured at the bottom of the umbilicus. The under (left) side is concave and has a vortex-shaped central depression shallower than the umbilical one. On this side the whorls are bluntly carinate and the inner whorl is plainly visible at the bottom of the central depression. The aperture is directed forwards in young specimens, but as the shell grows larger the lamellae arise and gradually develop, and the aperture gradually bends downwards. In older specimens a callous thickening of the lip may be found. A complete set of lamellae consists of two parietal and four palatal units. Not only as concerns the lamellae, but also the shell, this species is similar to *Australorbis janeirensis* (see Paraense and Deslandes, 1956), and to young *A. glabratus* and *A. peregrinus* from some populations whose specimens may develop, at early age, a transient set of apertural lamellae (Paraense, 1957; Paraense and Deslandes, 1958b).

The animal shows no appreciable difference from that of other small species of the genus. The pseudobranch is simple, thin and flat. The rectal ridge extends from the pseudobranch into the

pulmonary cavity, disappearing at the level of the stomach. There is no renal ridge. A dorsolateral ridge, facing the rectal one, runs parallel to the left side of the renal vein.

The genital organs are shown in fig. 3.

The ovotestis is composed of numerous sac-like diverticula, which are nearly always simple and less frequently bifurcate. The diverticula open into the ventral collecting canal, which continues into the thin proximal segment of the ovispermiduct. Then follows the seminal vesicle, whose parietal diverticula are poorly developed, as in *A. philippianus* (see Paraense and Deslandes, 1958a). The seminal vesicle gradually merges into the distal segment of the ovispermiduct, which is about 3-4 times as long as the proximal segment.

The spermiduct, highly sinuous at the beginning, follows a flexuous course in contact with the oviduct and, then, traverses the furrow formed by the pouch of the oviduct. At the point where it emerges from that furrow, it receives a single row of prostrate diverticula. The number of diverticula varied from 8 to 16 in our material. They are mainly bi- or trifurcate, less frequently unbranched or arborescent. Although some of them have a short stalk, they are mostly sessile, their branches arising almost directly from the prostate duct. The prostate duct continues into the vas deferens, which has no special characteristics.

The penis sheath varies from a little longer to about 4 times as long as the prepuce. It contains a penis that shows no essential differences from that of congeneric species. The prepuce is only a little wider than the penis sheath and is internally separated from the latter by a muscular diaphragm.

The oviduct is similar to that of other congeneric species, also having a large pouch of bosselated walls. The nidamental gland and uterus, taken conjointly, are from one and half times to thrice as long as the oviduct. The vagina is tubular and smooth-walled. The spermatheca is pear-shaped or club-shaped and has a narrow duct about as long as the spermathecal body.

The jaw is somewhat T-shaped, consisting of a wider upper piece, vertically striate, and two narrower lateral pieces. The following characteristics were observed in 5 specimens from Pinar del Rio (fig. 2): radula formula, 14-1-14 to 15-1-15; horizontal rows, 80 to 90; central tooth bicuspid; 4 to 6 laterals, 2 to 3

intermediates, 6 to 8 marginals.

Comparison with related species: In a conchological diagnosis between *A. albicans* and other congeneric species, there will always be place for uncertainty. In fact, even if no doubt arises as to the distinction between adult *A. albicans* and young shells from large species of *Australorbis,* there remain to be considered the similarities between the former and other lamellate shells. Of the Neotropical species studied by us, the adult *A. janeirensis* is always provided with a permanent set of apertural lamellae (Paraense and Deslandes, 1956). Under special environmental conditions, young individuals from other species, such as *A. glabratus* and *A. peregrinus,* may develop a transient set of lamellae which are resorbed as the shell grows larger (Paraense, 1957; Paraense and Deslandes, 1958b). Thus, a reliable diagnosis must be based on the anatomical characters associated, of course, with those of the shell.

A. albicans may be readily distinguished from *A. glabratus* by the absence of renal ridge, or of the pigmented line that precedes it in young specimens, and of the vaginal pouch (Paraense and Deslandes, 1955a, 1959); from *A. tenagophilus* (formerly called *A. nigricans* by us), *A. peregrinus, A. andecolus* and *A. pronus,* by the absence of the vaginal pouch (Paraense and Deslandes, 1955b, 1957, 1958b, c); and from *A. stramineus (= centimetralis)* by the absence of vaginal corrugation (Paraense and Deslandes, 1955c).

Despite the great similarity of its shell, when lamellate, to that of *A. janeirensis,* there are remarkable anatomical differences between the two species (for comparison, see Paraense and Deslandes, 1956). The penial complex, the vagina and the spermatheca of *A. janeirensis* are very long, the penial complex being about half as long as the whole female duct (oviduct, nidamental gland, uterus and vagina together); moreover, the penis sheath is from 4.7 to 7.6 times as long as the prepuce. In *A. albicans,* the penial complex, the vagina and the spermatheca are relatively very short, the penial complex being from 1/4 to 1/7 (about 1/5.5) as long as the female duct and, the penis sheath, from a little longer to about 4 times as long as the prepuce.

Of the *Australorbis* species so far studied by us, the most closely related to *A. albicans,* from the anatomical standpoint, is *A. philippianus* (see Paraense and Deslandes, 1958a). The latter

also has a small penial complex, the length of which is about 1/5 that of the whole female duct (range from 1/2.5 to 1/7). The two species may be distinguished by the characters of the penial complex and the prostate. The penis sheath is from a little longer to about 4 times as long as the prepuce in *albicans;* the two organs are about the same length in *philippianus,* the ratio between the former and the latter varying from 0.9 to 1.5. And the number of prostate diverticula is much smaller in *philippianus:* from 0 to about 6, as against 8 to 16 in the present sample of *albicans.*

Acknowledgement: We are indebted to the distinguished Cuban naturalists Miguel Jaume and Manuel Barro, for their helpful assistance to the senior author during his work in Cuba.

Summary

A description of the planorbid species *Australorbis albicans* (Pfeiffer, 1839) is presented. The following of its characters are considered as having diagnostic significance:

Shell up to about 7 mm. in diameter and 2.5 mm. in height, usually with 6 apertural lamellae in the adult; whorls about 3 1/2, rapidly widening, bluntly carinate underneath. Absence of renal ridge. Ovotestis diverticula simple or, less frequently, bifurcate. Seminal vesicle with poorly developed diverticula. Prostate diverticula mainly bifid or trifurcate, less frequently unbranched or arborescent, and arranged in a single row. Penis sheath from a little longer to about 4 times as long as the prepuce. Well developed pouch of oviduct. Vagina tubular and smooth-walled, without pouch or corrugation.

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X-RAY DIFFRACTION EXAMINATION OF TWO FORMS OF OLIVA SPICATA

By JERRY DONOHUE and KENNETH HARDCASTLE
Department of Chemistry, University of Southern California

Burch (1959) has discussed a problem concerned with identity of two forms [Cf. plate 17] of *Oliva spicata* (Röding, 1798) from La Paz, Baja California, which were brought to his attention by Mr. Naylor of San Diego, who stated that one form was rejected by Indian artisans on the basis that they shatter while being worked, the other form being acceptable in making various artifacts. Although at first glance both lots appeared identical, additional study revealed differences which may be summarized as follows:

Used shells:	Discarded shells:
Base of columella	Base of columella
white or pink,	light purple,
more obese,	more slender,
lower spire.	higher spire.

For convenience, Burch temporarily identified the acceptable shells as *Oliva spicata* var. *venulata,* the discarded ones as var. *ustulata,* and concluded that, since the two forms were easily separable, the lumping of all these variations under one name was odd. *O. venulata* (Lamarck, 1811) and *O. ustulata* (Lamarck, 1811) are usually included in the synonomy of *O. spicata,* e.g., by Johnson (1915) and Keen (1958).

In the hope of throwing additional light on this question, we have examined, by the method of x-ray diffraction, samples taken from both forms. These samples were taken from broken fragments, and the locations from which the samples were taken is indicated in Fig. 1, which presents an equatorial cross section of a characteristic shell. Shells from both lots showed the structure shown in Fig. 1, i.e., a translucent outer layer which encloses the pigment, a somewhat thicker, white, inner layer which also encloses pigment that, however, is not visible because this layer is thicker, and finally, a white, opaque, middle layer which contains no pigment. The outer and inner layers coalesce at the outer lip.

Samples taken from the outer and middle layers of both forms showed almost the same x-ray powder diffraction patterns. All

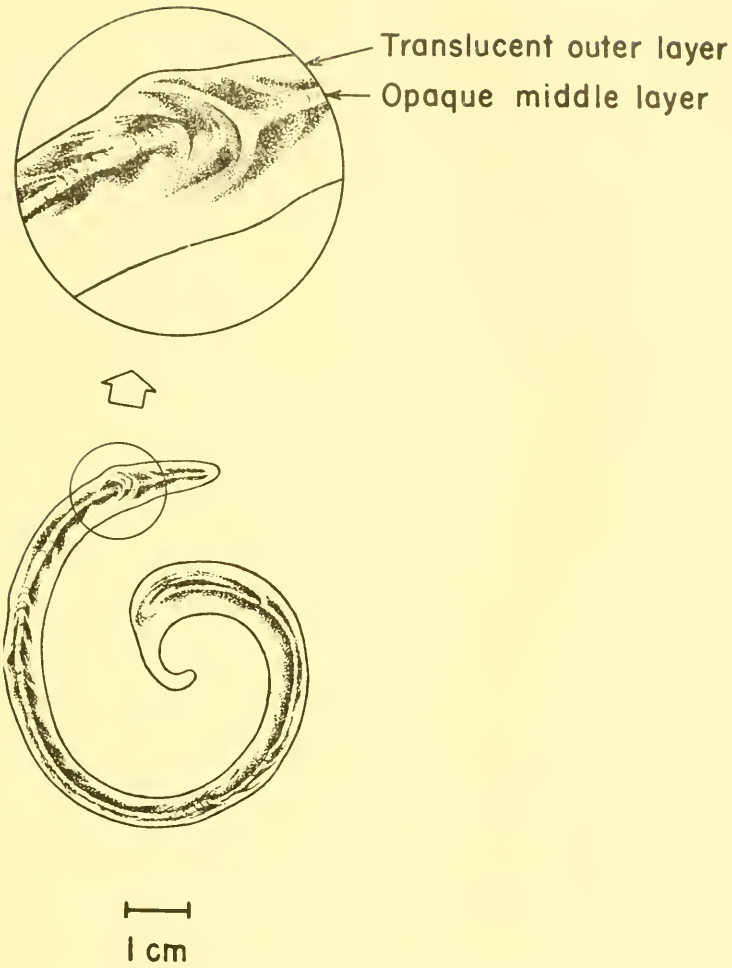

Fig. 1. Equatorial cross section of a characteristic specimen, showing the region from which the samples were selected. The dark areas represent the pigmentation, which was avoided in taking the samples for diffraction analysis.

their major and minor features exactly match the pattern reported by Swanson, Fuyat, and Ugrinic (1954) for the aragonite polymorph of calcium carbonate. An important difference occurs, however, in the case of both kinds of samples from the form acceptable to the Indians in that faint additional lines character-

istic of the powder pattern of the calcite polymorph of calcium carbonate (Swanson and Fuyat, 1953) may also be seen. We estimate that about 5% of calcite occurs in the outer layer, and somewhat more than half that much in the middle layers, of the utilized form. This calcite content is significantly different from that found in the samples from the form discarded by the artisans where none at all could be detected in the middle layer and only a trace in the outer layer.

It would thus appear that, in addition to the differences in shape and color between the two forms, there is also a difference in chemical constitution. There does not seem to be any *a priori* explanation as to why this difference should result in the difference in physical character noted by the artisans. Although this may or may not be relevant, calcite is considerably softer than aragonite (hardness 3, as compared to 4, Mohs scale), but possibly the shattering property may be the result of some other effect, e.g., differences in the orientation of the crystallites in the shell.

The question of which are the appropriate names to assign to these forms is discussed by Burch and Burch (1962).

Experimental Details. The x-ray diffraction patterns were recorded photographically by the standard techniques in a Norelco powder camera, with CuKα radiation, filtered through nickel foil. All lines out to spacings of $d > 1.15$ Å were measured. Relative intensities were estimated visually. The 38 lines in this region reported for aragonite were all observed at the expected spacings and with the correct relative intensities for the four different types of samples. The calcite lines observed in the case of the samples from the "accept" form, all with very faint intensity, were those at $d = 3.86$ Å and 3.035 Å. These are two of the strongest lines reported by Swanson and Fuyat for calcite. All the other strong calcite lines listed by them are coincident with lines due to aragonite and were not observed. The only calcite line observed in the case of the samples from the outer layer of the "reject" form was the one at spacing 3.035 Å, which is by far the strongest line of that pattern; the next most intense lines were too weak to be observed. The calcite content was estimated by comparison of the intensities of the 3.035 Å line of calcite with the 2.871 Å line of aragonite.

Upper and lower, left figs., holotype of *Oliva rejecta* Burch & Burch. Upper and lower, right figs., *Oliva venulata* Lamarck.

Maxwell Smith, 1888-1961

Fig. 1 was prepared by Mrs. Maryellin Reinecke. We wish to thank Mr. John Q. Burch for bringing this problem to our notice and for furnishing the specimens of both forms.

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NEW SPECIES OF OLIVA FROM WEST MEXICO

By JOHN Q. and ROSE L. BURCH

The literature on the history and many variations of the species commonly known as *Oliva spicata* (Röding, 1798) is voluminous. The disposition of most modern authors has been to lump all varieties as forms of one species. In our opinion, the last word has not been written on this assemblage.

In our work, Minutes of the Conchological Club of Southern California, no. 184, p. 20, Jan. 1959, we discussed the problem of the two species studied by Donohue and Hardcastle. Mr. W. E. Naylor of San Diego, a dealer in commercial shells, referred this problem to us. His trade in olives is largely to the Indians who use the shells to make various artifacts. The Indians rejected one variety claiming that they shatter when worked and are unsatisfactory. The acceptable variety is known to the trade as *Oliva venulata* Lamarck, 1811. These shells are heavier, with lower spire, and more obese than the discarded lot. These specimens consistently have the base of the columella with a white color and perhaps a tinge of pink. Shells of the rejected lot are more slender, higher spired, and the base of the columella is consistently a light purple instead of white. The interior of both is a bluish white. At first glance the shells in question seem to be very similar, but after a little study they readily separate into two forms. The studies of Donohue and Hardcastle have shown that the two forms differ in the chemical analysis of the shell. Both

forms are found on the same tide flats at La Paz, Baja California, Mexico, with no intergrades in many hundreds of specimens. Certainly many species are recognized upon much more meagre grounds.

In our preliminary discussion, for convenience, we assigned the discarded form to *Oliva ustulata* Lamarck, 1811. Several very different forms have been recognized by various authors under this name. Tryon in the Manual of Conchology thought it to be a variety of the Atlantic *Oliva reticularis* Lamarck, 1811. Charles Johnson thought it to be a form in which the pattern of the shell is obscured by a dark brown layer. In our opinion, the name *Oliva ustulata* Lamarck cannot be used for this form. Seemingly the species of *Oliva* under discussion has been considered a form of the typical by all authors we have consulted. Therefore, we feel justified in giving it a name and the status of a new species.

OLIVA REJECTA, new species. Plate 17, left figs.

Shell cylindrically oblong; spire exserted, prominent; color white with a closely reticulate pattern of chocolate; base of columella purple, swollen, with 4 plaits; interior of aperture bluish white. Length: 35.5 mm. Greatest diameter: 15 mm. Type locality: tide flats at La Paz, Baja California.

A comparison of the dimensions of the type of the new species with those of a normal specimen of *Oliva venulata* Lamarck is of interest. Both specimens measure exactly 35.5 mm. in length, but the greatest diameter of *Oliva rejecta* is 15 mm., while that of *Oliva venulata* is 17.5 mm. Also, the greatest diameter of *Oliva rejecta* is much lower on the body whorl.

The holotype is to be deposited in the California Academy of Sciences, San Francisco, no. 12400. Fifty paratypes will be distributed to various institutions.

NOTES AND NEWS

BULIMULUS DEALBATUS JONESI Clench appears to be *Bulimulus mooreanus* (Pfeiffer) which has been introduced into Alabama. It is somewhat smaller than is usual for the species in Texas, but is otherwise typical. Unlike *B. dealbatus* (Say), it estivates on the weeds where it can be found in large numbers even in the hottest part of the summer. — LESLIE HUBRICHT.

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